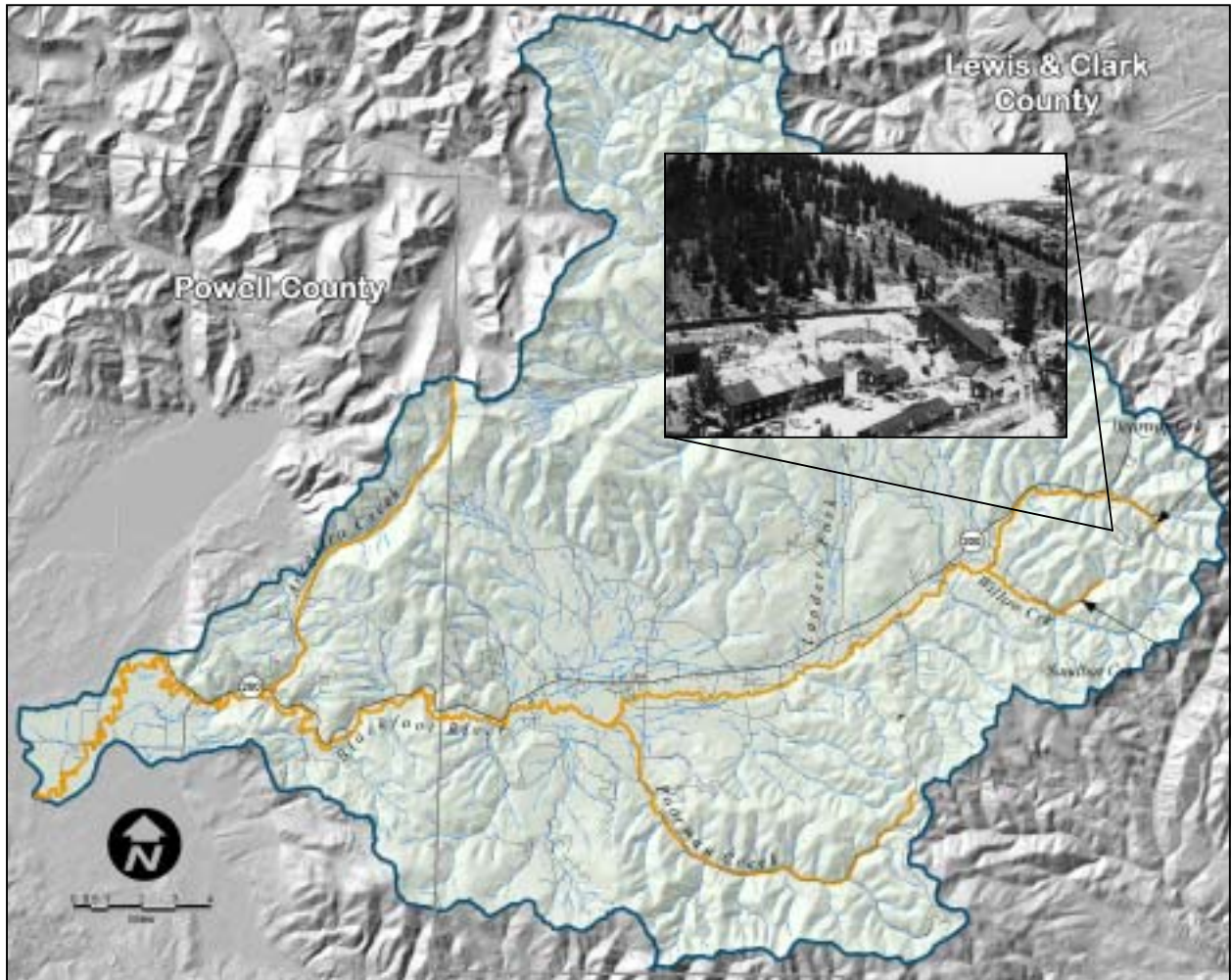

**WATER QUALITY RESTORATION PLAN
FOR METALS IN THE
BLACKFOOT HEADWATERS TMDL PLANNING AREA**



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Technical Lead:

Bob Anderson, Hydrometrics, Inc.

Dean Yashan, Montana Department of Environmental Quality

Significant Contributors:

Mark Walker, Hydrometrics, Inc.

Tina Bernd-Cohen, Blackfoot Challenge Inc.

Cover:

Blackfoot Headwaters TMDL Planning Area with Mike Horse Mine inset photo (circa 1940's).

EXECUTIVE SUMMARY:

WATER QUALITY RESTORATION PLAN FOR METALS IN THE BLACKFOOT HEADWATERS TMDL PLANNING AREA

Section 303(d) of the Federal Clean Water Act requires states to identify those water bodies within its boundaries that do not meet water quality standards, to prioritize the listed water bodies according to the severity of pollution and their intended beneficial uses, and to develop TMDLs for these water bodies. A Total Maximum Daily Load (TMDL) is a pollutant budget establishing the maximum amount of a pollutant that a water body can assimilate without exceeding water quality standards. This document is a water quality restoration plan that incorporates TMDLs for metals in the Blackfoot Headwaters TMDL Planning Area. The overall goal of this document is to identify an approach to improve water quality to the level where all beneficial uses are restored and protected. By fulfilling this goal, this document fulfills the requirements of Section 303(d) of the Federal Clean Water Act and Title 75, Chapter 5, Part 7 of the Montana Water Quality Act. Table E-1 contains a summary of this water quality restoration plan.

Table E-1. Water Quality Restoration Summary Information

Water Bodies & Pollutants of Concern	<u>30 individual water body/pollutant combinations addressed as follows:</u> <ul style="list-style-type: none"> - Blackfoot River above Landers Fork (pollutants: cadmium, copper, iron, lead, manganese, zinc) - Blackfoot River below Landers Fork (pollutants: aluminum, cadmium, iron, zinc) - Beartrap Creek (pollutants: cadmium, copper, iron, lead, manganese, zinc) - Mike Horse Creek (pollutants: aluminum, cadmium, copper, iron, lead, manganese, zinc) - Sandbar Creek (pollutants: aluminum, copper, iron, manganese) - Poorman Creek (pollutants: cadmium, copper, lead)
Impaired Beneficial Uses	<ul style="list-style-type: none"> - Blackfoot River above Landers Fork (impaired uses: aquatic life; cold water fish; drinking water supply) - Blackfoot River below Landers Fork (impaired uses: aquatic life; cold water fish) - Beartrap Creek (impaired uses: aquatic life; cold water fish; drinking water supply) - Mike Horse Creek (impaired uses: aquatic life; cold water fish; drinking water supply) - Sandbar Creek (impaired uses: aquatic life; cold water fish; drinking water supply) - Poorman Creek (impaired uses: aquatic life; cold water fish)
Pollutant Sources	- Metals: Mine disturbances, natural background
Target Development Strategies	<ul style="list-style-type: none"> - Numeric metals concentrations in water column for aquatic life/fishery and for drinking water/domestic use support; hardness adjustments to numeric targets must be incorporated - Elimination of objectionable deposits from metal precipitates - Metals in stream sediments may not impede beneficial uses - Biota (periphyton, macroinvertebrate) equal to or better than reference conditions
TMDLs	- Based on numeric concentration targets multiplied by stream flow (all metals, various flow conditions)

Table E-1. Water Quality Restoration Summary Information

Allocations	<ul style="list-style-type: none"> - Performance-based load allocations for mine disturbances in the Upper Blackfoot Mining Complex (UBMC) (applies to all metals TMDLs in Mike Horse and Beartrap Creeks and the Blackfoot River) - Performance based waste load allocation for discharge permit based on meeting water quality standards either within the discharge or within the mixing zone (applies to multiple metals from a wetlands treatment system permitted discharge within the UBMC) - Additional load allocations to tributary drainages where future monitoring identifies metals impairment conditions; (applies to specific metals associated with tributary impairment conditions and could result in additional load reductions for metals of concern in the Blackfoot River) - Load allocations to identified mining sources and natural background loads so that TMDL conditions are satisfied (applies to metals in Sandbar and Poorman Creek drainages)
Restoration Strategies	<ul style="list-style-type: none"> - UBMC restoration efforts currently underway for mine disturbances as identified within the temporary water quality standards (primary restoration approach for Mike Horse and Beartrap Creeks and the Blackfoot River) - Further characterization of identified mine disturbances in tributary drainages not covered by the UBMC (Sandbar Creek, Poorman Creek/Swansea Gulch) - Further characterization of Poorman Creek and Willow Creek to better define impairment conditions and/or loading sources - Monitoring of key tributary drainages to the Blackfoot River where impairment conditions have yet to be fully evaluated and subsequent identification and characterization of significant metals sources (Seven Up-Pete, Alice, Hogum, Hardscrabble Creeks, others) - Pursue restoration for significant mining and other metals sources within tributary drainages outside UBMC responsibilities (Poorman/Swansea, Sandbar Creek, other tributary streams where appropriate) - Adaptive management approach based on water quality monitoring and implementation of restoration activities (all water bodies)
Margin of Safety	<ul style="list-style-type: none"> - Metals targets apply during various flow conditions with considerations for changing hardness conditions - Adaptive management approach that commits to future monitoring and assessment - Built in margins of safety within existing numeric water quality standards - Application of most protective numeric standards, typically the chronic aquatic life standard - Addition of biota targets and sediment chemistry targets - Impairment determinations consider all relevant data and seasonality in a conservative manner - Significant monitoring efforts associated with metals related watershed characterization and restoration efforts
Seasonal Considerations	<ul style="list-style-type: none"> - Metals impairment and loading conditions evaluated at various flow conditions - Metals TMDLs incorporate stream flow as part of the TMDL equation - Metals targets apply during various flow conditions with considerations for changing hardness conditions - Existing and future monitoring addresses varying flow conditions

Blackfoot Headwaters Planning Area

The Blackfoot Headwaters Planning Area (Planning Area) includes the Blackfoot River watershed from its headwaters to the confluence of the Blackfoot River and Nevada Creek. The planning area includes approximately 318,000 acres within portions of Lewis and Clark County and Powell County in west-central Montana. The Blackfoot River has a mapped length of about 60 miles through the Planning Area. Major tributaries include Willow Creek, Alice Creek, Landers Fork, Poorman Creek, and Arrastra Creek. All surface waters within the Planning Area are classified as B-1 (ARM 17.30.607). B-1 classified waters are suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply (ARM 17.30.623).

The predominant source of metals-related water quality impairment in the Planning Area is historic mining activity. The most extensive mining occurred in an area near the Blackfoot River headwaters referred to as the Upper Blackfoot Mining Complex (UBMC) or Heddleston Mining District. The UBMC has been the focus of an extensive mine reclamation program initiated in 1993.

Metals-Related Water Quality Impairment

Montana's 2002 303(d) list represents the most current listing of impaired water bodies in need of TMDL development. As additional data is obtained within a watershed, new impairment conditions are sometimes identified, thus adding to TMDL development requirements that will be captured within future 303(d) lists. 303(d)-listed and other water bodies in need of TMDL development for metals in the Planning Area include portions of Sandbar Creek, Mike Horse Creek, Beartrap Creek, Poorman Creek, the Blackfoot River from its headwaters to the confluence with Landers Fork, and the Blackfoot River from Landers Fork to the confluence of Nevada Creek (Table E-2). The beneficial uses most commonly cited as "not fully supported" include aquatic life support, cold water fishery, and drinking water supply. The predominant metals of concern include aluminum, cadmium, copper, iron, lead, manganese and zinc. TMDL development and restoration planning for causes of impairment other than metals (i.e., sediment, habitat degradation) are addressed in a separate Water Quality and Habitat Restoration Plan/TMDL document for the Blackfoot Headwaters TMDL Planning Area.

Table E-2. Planning Area Water Bodies In Need Of TMDL And Restoration Plan For Metals.

Water Body	Stream Segment Number	Stream Miles	Beneficial Uses not Fully Supported	Pollutants of Concern¹
Blackfoot River from Landers Fork to confluence of Nevada Creek	MT76F001-020	48.3	Aquatic life Cold water fishery	Aluminum, Cadmium, Iron, Zinc
Blackfoot River from headwaters to confluence with Landers Fork	MT76F001_010	16.4	Aquatic life Cold water fishery Drinking water supply	Cadmium, Copper, Iron, Lead, Manganese, Zinc
Beartrap Creek (Mike Horse Cr to mouth)	MT76F002-040	0.5	Aquatic life Cold water fishery Drinking water supply	Cadmium, Copper, Iron, Lead, Manganese, Zinc

Table E-2. Planning Area Water Bodies In Need Of TMDL And Restoration Plan For Metals.

Water Body	Stream Segment Number	Stream Miles	Beneficial Uses not Fully Supported	Pollutants of Concern¹
Mike Horse Creek	Number not assigned yet	0.6	Aquatic life Cold water fishery Drinking water supply	Aluminum, Cadmium, Copper, Iron, Lead, Manganese, Zinc.
Sandbar Creek (from forks to mouth)	MT76F002-060	1.6	Aquatic life Cold water fishery Drinking water supply	Aluminum, Copper, Iron, Manganese
Poorman Creek (headwaters to mouth)	MT76F002-030	14.0	Aquatic life Cold water fishery	Cadmium, Copper, Lead

1- Based on recent (1996-2002) water and sediment chemistry data

Restoration Target/TMDL Development

This restoration plan summarizes available relevant water quality data, documents the magnitude of metals-related impairment, identifies specific metals loading sources, identifies water quality restoration targets, establishes TMDLs (acceptable pollution loads), and establishes load allocations for each of the water bodies listed as impaired for metals.

Water quality restoration targets are based primarily on the numeric water quality criteria included in the Montana water quality standards. The numeric criteria are intended to be protective of beneficial uses, such as aquatic life support, by establishing maximum allowable concentrations for metals based on toxic or carcinogenic characteristics. Restoration targets are also established to avoid development of metal-precipitate streambed coatings and toxic concentrations of metals in sediments, both of which can impede aquatic life support. As an additional measure of water quality restoration, biota targets associated with macroinvertebrate and periphyton communities also apply. These communities must show no impairment from metals as compared to a known reference condition.

The amount (or load) of a metal (in lb/day) that a water body can assimilate without exceeding the numeric water quality criteria (and thus the restoration targets) is a function of the streamflow rate (dilution capacity), and, for some metals, the water hardness. Therefore, the metals TMDLs (which establish the maximum allowable metal loads in each water body) must account for the full range of possible streamflow and water chemistry conditions. This is accomplished by basing the TMDL, in the form of an equation, on the requirement that applicable water quality standards be met and beneficial uses protected at all times, and under all streamflow and water chemistry conditions. The TMDL equation is as follows:

$$TMDL (lb/day) = X (\mu g/L)(Y cfs)(0.0054)$$

Where:

X= the numeric water quality criteria in micrograms per liter (parts per billion) for a specific metal adjusted for water hardness as necessary;

Y= streamflow rate in cubic feet per second;

0.0054 = conversion factor.

TMDLs are presented in this document for each water body based on typical high flow and low flow conditions as determined from existing hydrologic data. TMDLs can be determined for any streamflow and water hardness conditions encountered by using the equation listed above. In this fashion, implementation of the metals TMDLs should be protective of intended beneficial uses and water quality standards under all conditions and at all times.

Results

Sandbar Creek

Water quality data show that Sandbar Creek exceeds numeric water quality criteria for aluminum, iron, and copper. Biological data also indicate metals-related impairment, as do elevated metals concentrations in stream sediments. Iron and manganese concentrations also exceed guidance values for drinking water use support. Two historic mine waste dumps and a section of road containing apparent mine waste material are identified as probable sources of metals-related impairment in Sandbar Creek. Restoration strategies for Sandbar Creek include reclamation of the three probable metals-loading sources, and supplemental surface water and sediment sampling to support reclamation planning, and to determine if other potential metals loading sources may be present in the drainage.

Willow Creek

Water quality data for high and low flow conditions do not show any metals concentration exceeding numeric water quality criteria for Willow Creek. Elevated metals concentrations in stream sediments (primarily arsenic, copper, manganese, and iron) and biological data suggest the possibility of an impairment condition due to metals, although at this time Willow Creek is not identified as an impaired water body. Metals loading from Sandbar Creek is an identified source of metals to Willow Creek. Therefore, the restoration strategy for Willow Creek is focused on restoration work in Sandbar Creek and efforts to ensure that there are no significant metals sources in the remaining upper part of the Willow Creek drainage.

Poorman Creek

In Poorman Creek drainage, available water quality data indicate that mine waste rock, mill tailings, and possible discharges from one or more mine adits (mine tunnel) associated with the Swansea Mine are the primary sources of metals-related water quality impairment. Metals concentrations in a tributary draining the Swansea Mine area exceed water quality standards for the metals cadmium, copper and lead. Although available water quality data reveal no exceedences of numeric water quality criteria in the mainstem of Poorman Creek, degraded biotic populations documented through fishery and periphyton surveys, in conjunction with elevated metals concentrations in stream sediments, support the listing of Poorman Creek as impaired for metals. Restoration strategies for Poorman Creek include reclamation of the Swansea Mine area, and implementation of an environmental monitoring program designed to support reclamation planning, and to provide a more complete assessment of impairment conditions and possible metals loading sources throughout the drainage.

Beartrap Creek and Mike Horse Creek

The impaired portions of Beartrap Creek and Mike Horse Creek are significantly impacted by historic mining activities associated with the Upper Blackfoot Mining Complex (UBMC). Identified sources of metals-related impairment include seepage from a tailings impoundment,

various mining related sources in Mike Horse Creek, and leaching of metals and acidity from floodplain tailings and waste rock piles. Existing water quality data show that metals concentrations in Beartrap Creek and Mike Horse Creek exceed numeric water quality criteria for cadmium, copper, lead and zinc. Metals concentrations in Mike Horse Creek also exceed numeric water quality criteria for aluminum, and metals concentrations in Beartrap Creek also exceed numeric water quality criteria for iron. Iron and manganese concentrations in both streams also exceed guidance values for drinking water use support. Biological data and elevated metals concentrations in stream sediments support the metals-impairment determination.

The UBMC, which includes the listed portion of Beartrap Creek in addition to Mike Horse Creek, is the focus of an extensive mine reclamation and water quality restoration program initiated in 1993. The reclamation program is currently being conducted under direction of the Montana Department of Environmental Quality, with future activities to occur under the Federal CERCLA program as well. Program requirements include identification and restoration of all human-caused sources of metals-related impairment, with the ultimate goal of attaining compliance with B-1 classification water quality standards by 2008, to the extent considered achievable. Based on these goals and requirements, it is presumed that the UBMC mine reclamation program will result in attainment of the TMDL water quality restoration targets in Beartrap Creek and Mike Horse Creek. In recognition of these water quality restoration commitments, a performance-based approach is adopted for load allocation and restoration planning in both streams. The performance-based approach relies on the current commitments and goals of the UBMC reclamation program for achievement of the goals and requirements of the TMDLs and the water quality restoration plan.

Blackfoot River

The segment of the Blackfoot River from the headwaters downstream to Landers Fork shows varying levels of metals-related impairment. Water quality data show that the upstream portion of this stream segment routinely exceeds numeric water quality criteria for the metals cadmium, copper, iron, lead, and zinc. Iron and manganese concentrations also exceed guidance values for drinking water use support. Metals concentrations decrease in a downstream direction to the point where exceedences of metals-related numeric water quality criteria typically occur during high flows only, and ultimately do not occur at all immediately upstream of Landers Fork. Water quality data for the segment of the Blackfoot River from Landers Fork to Nevada Creek occasionally exceeds numeric water quality criteria during high flows for cadmium, iron, aluminum, and zinc.

Identified sources of metals-related water quality impairment in the upper river segment are associated with the UBMC, and include inflow of metals-bearing surface water from two tributaries (Bear Trap Creek and Stevens Gulch), discharge from a water treatment system, and leaching of metals and acidity from mine waste situated along the floodplain. All of these sources are identified and addressed in the UBMC mine reclamation program. Therefore, load allocation and restoration planning in the upper river segment relies on the performance-based approach described above for Beartrap Creek and Mike Horse Creek. Sources of metals-related impairment in the lower river segments are not as well characterized as in the upper segment, although metal loads originating from the UBMC likely constitute the greatest impact to water

quality in the downstream river segments as well. Therefore, completion of currently scheduled mine reclamation activities at the UBMC should also address most metals-related water quality impairments in the downstream segments of the Blackfoot River. Other possible metals loading source areas identified in this restoration plan in the downstream river segments include:

1. An extensive marsh system in the Blackfoot River drainage bottom through which loads of several metals in the Blackfoot River increase,
2. Tributary drainages included on the 303(d) list (Poorman Creek and Sandbar/Willow Creeks);
3. Tributary drainages (e.g. Alice Creek, Hogum Creek, Hardscrabble Creek, and Seven Up-Pete Creek) not included on the 303(d) list but available water quality data indicate that these streams may exceed water quality standards on a periodic basis.

The restoration strategy for the metals-listed segments of the Blackfoot River primarily relies on completion of the current water quality restoration commitments and scheduled reclamation activities at the UBMC. In addition, a surface water and sediment sampling program will be implemented to further delineate potential metals loading sources not included in the current reclamation program commitments, and to provide for more detailed load allocation and restoration planning on the metals-listed segment of the Blackfoot River.

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SECTION 1.0

INTRODUCTION

Under Montana law (MCA), an impaired water body is defined as a water body or stream segment for which sufficient credible data indicates non-compliance with applicable water quality standards (MCA 75-5-103). Section 303 of the Federal Clean Water Act requires states to submit a list of impaired water bodies or stream segments (known as a 303(d) list) to the U.S. Environmental Protection Agency (EPA) every two years. The Montana Water Quality Act further directs Montana Department of Environmental Quality (MDEQ) to develop Total Maximum Daily Loads (TMDLs) for all water bodies appearing on the 303(d) list as impaired or threatened (MCA 75-5-703).

A TMDL is a pollutant budget for a water body identifying the maximum amount of a particular parameter that a water body can assimilate without causing applicable water quality standards to be exceeded. TMDLs are often expressed in terms of an amount, or load, of a particular pollutant (expressed in units of mass per time such as pounds per day). TMDLs can also be expressed as the maximum allowable concentration of a parameter, as a required load reduction, or as specific mandates assuring the water quality standards are met (e.g., no toxic concentrations of sediment metals concentrations). TMDLs account for loads from point and nonpoint sources in addition to natural background sources, and are generally developed and presented as part of an overall water quality restoration plan (WQRP). The WQRP includes not only the actual TMDL, but also includes information that can be, or in some cases, is being used to effectively restore water quality.

This document is a Water Quality Restoration Plan (WQRP) and Total Maximum Daily Load (TMDL) for metals in the Blackfoot Headwaters TMDL Planning Area. The overall goal of this document is to identify an approach to improve metals-related water quality to a level where beneficial uses are fully supported for all impaired water bodies in the Planning Area, and to ensure that Montana water quality standards are not violated. Non-metals-related causes of water quality impairment in the Planning Area (e.g., siltation, habitat alterations) are addressed in a separate Water Quality and Habitat Restoration Plan/TMDL. Some of the habitat and sediment related issues addressed in this other plan are associated with UBMC historic metals mining impacts and impacts from the Mike Horse Dam failure, and are therefore linked to restoration efforts in this plan.

1.1 Planning Area Characterization

The following description of the Blackfoot Headwaters TMDL Planning Area is taken primarily from the Planning Area Phase I Assessment Report (Confluence Consulting et al., 2002).

1.1.1 Location and Description of Watershed

The Blackfoot Headwaters TMDL Planning Area is located northwest of Helena, Montana in portions of Lewis and Clark and Powell counties (Figure 1-1). The Planning Area extends from the continental divide on the east to the confluence of the Blackfoot River and Nevada Creek on

the west, and encompasses approximately 495 square miles (318,000 acres). The physical geography of the Planning area varies from high elevation, steep glaciated mountain ranges in the north and lower non-glaciated mountains in the south, separated by the east-west trending Blackfoot Valley. Elevations range from approximately 4,250 feet above mean sea level near the confluence of the Blackfoot River and Nevada Creek, to over 8,500 feet in the northern portion of the Planning Area.

The Blackfoot River originates at the confluence of Beartrap and Anaconda Creeks, both of which flow westward from the continental divide. The main stem of the Blackfoot River has a mapped length of about 60 miles in the Planning Area and an average gradient of 0.98 percent. Major tributaries, in upstream to downstream order, include Alice Creek, Willow Creek, Landers Fork, Poorman Creek, and Arrastra Creek (Figure 1-2).

1.1.2 Geologic Setting

Bedrock within the Planning Area consists primarily of Proterozoic aged metasedimentary rocks of the Belt Supergroup. Predominant bedrock formations and lithologies include the Precambrian Newland Limestone, Spokane Shale, and Helena Limestone (Roberts, 1986). Surface exposures of these bedrock units cover about 55 percent of the area. Cambrian and Mississippian sedimentary rocks outcrop locally near the headwaters of Landers Fork.

Late Cretaceous and early Tertiary intrusive activity led to the formation of numerous metallic ore deposits in the Planning Area. Several gold, silver, lead, zinc, and copper ore deposits have been identified and developed since the late 1800s. Areas of significant historic mining activity include the Upper Blackfoot Mining Complex (UBMC) otherwise known as the Heddleston District or Mike Horse Mine, the Seven-Up Pete Mine area, and the Swansea Mine in Poorman Creek drainage although historic mining activity has occurred throughout the Planning Area (Figure 1-2). Historic mining development represents the primary source of metals-related water quality impairment in the Planning Area.

Approximately 40% of the Planning Area is mantled by unconsolidated glacial drift or alluvium. Alluvial deposits cover most drainage bottoms and reach depths of several hundred feet in portions of the Blackfoot Valley. Glacial drift covers much of the lower elevation uplands north of the Blackfoot River valley bottom, especially in the Landers Fork watershed. Glacial landforms, including glacial moraines and outwash plains, heavily influence the geomorphology of the Blackfoot River valley. For instance, glacial debris deposited in the drainage bottom has resulted in formation of an extensive marsh complex along the Blackfoot River throughout much of the Planning Area. This marsh system heavily influences metals transported through, and impairment conditions within, the Blackfoot River. Glacial meltwaters also deposited thick accumulations of coarse sediments (glacial outwash) in larger tributary drainages and on the Blackfoot Valley floor. Due to the highly permeable nature of these outwash sediments, streams generally lose water through infiltration, and often go dry, where they cross the outwash plains, such as the Blackfoot River between Landers Fork and the Town of Lincoln.

1.1.3 Climate

Climatic conditions vary significantly throughout the Planning Area due to considerable elevation change and geographic influences. Conditions are generally characterized by long, cold winters and short, moderately hot summers. Average monthly minimum and maximum temperatures as recorded at the Lincoln Ranger Station (near the town of Lincoln) for the period 1948 - 2000 range from 10.0° and 26.7°F in January, to 41.9° and 80.8°F in July.

Average annual precipitation ranges from less than 15 inches near the confluence of the Blackfoot River and Nevada Creek, to more than 50 inches near the headwaters of Copper Creek (Figure 1-2), with much of the precipitation occurring as snow. Based on a basin-wide average annual precipitation of 2.4 feet (White Horse Associates, 1996), the volume of annual precipitation in the Planning Area is approximately 760,000 acre-feet.

1.1.4 Land Ownership and Use

Approximately 64% of the Planning Area is under US Forest Service management including 13% USFS Wilderness. Private property holdings comprise approximately 30% of the Planning area (of which Plum Creek Timber owns about 6.5%), with subordinate amounts of land owned by the State of Montana (approximately 4.5%), the Bureau of Land Management (BLM), and the US Fish and Wildlife Service, (Confluence et al., 2002, MDEQ, 2001a). The dominant land uses in the watershed are livestock grazing, timber harvest, recreation, and minor dry land and irrigated agriculture.

1.1.5 Fisheries

The Blackfoot Headwaters Planning Area supports a largely native assemblage of fish comprised of eight species within four families (Confluence et al, 2002). Salmonids include the native bull trout, westslope cutthroat trout, mountain whitefish, and the introduced brook trout and brown trout. Two species of catostomid, longnose sucker and largescale sucker, occur in the upper Blackfoot watershed. The longnose dace is the sole member of the minnow family and the slimy sculpin is presumably the only member of the cottid family occurring in the upper Blackfoot River watershed.

The Planning Area is considered extremely important in the conservation and recovery of bull trout. Copper Creek and Landers Fork have been identified as bull trout core areas by the Montana Bull Trout Scientific Group (1995). As a result, these areas are the focus of restoration and monitoring activities in the management of this sensitive species. Factors contributing to the decline of bull trout throughout their range include siltation, increased water temperatures, introduced fish species, and passage barriers (culverts, diversions, etc) that can restrict the movements of this highly migratory species. The Blackfoot Headwaters Planning Area is a stronghold for westslope cutthroat trout; another species that has experienced marked declines.

A number of fish inventory studies have been conducted in the Blackfoot Headwaters Planning Area. The Montana Department of Fish, Wildlife and Parks performed fisheries inventories in the Upper Blackfoot River and select tributaries in the early 1970s, 1988, and 1999. Results of

the most recent surveys indicate that populations of cutthroat trout near the Blackfoot River headwaters (upstream of Highway 279 (Fletcher Pass Road), Figure 1-2) continue a trend of declining numbers noted since the early 1970s (MDFWP, 2000). Based on the timing of this trend, impacts from a 1975 tailings dam breach at the historic Mike Horse Mine are cited in the report as the likely cause (see Section 1.4). The MDFWP report also notes generally low fish population numbers in several tributary drainages, in particular Seven Up-Pete Creek (Figure 1-2). The current fishery survey data were utilized by MDEQ in determining the distribution of impaired water bodies in the Planning Area.

BioAnalysts, Inc. (1996) conducted an assessment of fish populations in a portion the Planning Area in 1996. The purpose of this assessment was to obtain baseline fisheries and habitat data in the vicinity of a large proposed mine development (the McDonald Gold Project). The fishery survey found that salmonids were most abundant in Cadotte and Hardscrabble creeks and lowest in the Landers Fork (Figure 1-2). Copper and Alice creeks had intermediate populations of salmonids.

1.2 Water Quality Standards

Montana surface water quality standards, including water body classifications, beneficial uses, and numeric and narrative standards, are established in Title 17, Chapter 30, subchapter 6 of the Administrative Rules of Montana (ARM 17.30.601 et. seq.). The surface water quality standards are the benchmark used in making beneficial use support decisions and determining if a water body is impaired and in need of TMDL development. The water quality standards also form the basis for developing water quality restoration targets during TMDL development. Following is a brief synopsis of metals-related surface water quality standards and associated issues applicable to the Blackfoot Headwaters Planning Area.

1.2.1 Water Body Classification and Beneficial Uses

The Montana Water Quality Act requires the Montana Board of Environmental Review to classify all state waters in accordance with their current and future most beneficial uses (MCA 75-5-301). Specific numeric and narrative water quality criteria are then established for each water use classification to ensure protection of the intended beneficial uses. All surface waters within the Planning Area are classified as B-1 waters (ARM 17.30.607) with the following intended beneficial uses:

- Growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers;
- Contact recreation;
- Agriculture water supply;
- Industry water supply; and
- Drinking, culinary and food processing purposes after conventional treatment.

1.2.2 Numeric and Narrative Standards

Numeric water quality standards (water quality standards based on a specific concentration or value) are presented in Circular WQB-7 Montana Numeric Water Quality Standards (MDEQ, 2001b). Narrative water quality standards and standards that are based on a numeric variance from naturally occurring conditions within a water body are presented in the Surface Water Quality Standards (ARM 17.30.623 & 637).

WQB-7 lists numeric water quality criteria for protection of aquatic life and for protection of human health. For most metals, aquatic life criteria are established for both acute and chronic conditions. The chronic standard for some metals is equal to the acute standard. For the more common situation where the two are not equal, the chronic standard is always lower than the acute standard. In some situations, there is only a chronic standard, such as for iron, or only an acute standard, such as for silver. While the water quality standards state that the acute aquatic criteria may not be exceeded in B-1 waters at any time, the chronic aquatic criteria may be exceeded on an instantaneous basis as long as the average concentration of that parameter measured over any 96-hour (or longer) period does not exceed the chronic aquatic criteria (WQB-7, Footnote 4). Following are some notes regarding the application of the WQB-7 numeric water quality standards to this water quality restoration plan:

- Based on the B-1 classification beneficial uses, both the human health standards and aquatic life standards apply to surface waters within the Planning Area. When evaluating impairment conditions and establishing water quality restoration targets in this plan, water quality data were compared to either the aquatic life standard or human health standard, whichever was lower (more stringent).
- Even though there is a lack of information regarding the average metals concentrations for any 96-hour or longer period from the Planning Area, the more stringent chronic aquatic criteria (as opposed to the acute criteria) were used in evaluating impairment conditions and setting water quality restoration targets in this Plan. The application of the chronic criteria is based on the assumption that any one sample event is representative of the previous 48 hours and the following 48 hours.
- The aquatic life standards for several metals (i.e., copper, cadmium, lead, zinc, silver) are a function of water hardness. As hardness decreases (the water becomes more dilute), the applicable numeric standard also decreases (becomes more stringent). In most cases, stream water hardness decreases with increasing flow during spring runoff, resulting in lower applicable aquatic life standards during spring runoff periods. To account for this, impairment conditions and restoration targets are established for both high flow and low flow periods, so that restoration planning will be protective of water quality under various hydrologic conditions. Additional information regarding development of water quality restoration targets and TMDLs is presented in Appendix A.
- For iron and manganese, the water quality standards listed under human health in WQB-7 are not based on specific numeric values since these metals are not categorized as toxins or carcinogens. Instead, WQB-7 states that concentrations of these parameters “must not

reach values that interfere with the uses specified in the surface and groundwater standards.” WQB-7 further states that the Secondary Maximum Contaminant Levels established by EPA (based on protection of aesthetic issues such as taste, odor, staining) of 300 µ/L (micrograms per liter, or parts per billion) for iron and 50 µg/L for manganese may be considered as guidance in determining if a certain concentration interferes with the specified uses. For the Blackfoot Headwaters Planning Area, the guidance values stated above were used in conjunction with other anecdotal information to determine if concentrations of iron or manganese constitute impairment of a water body. Additional information regarding the application of the iron and manganese guidance values is presented in Appendix A.

- As discussed in Section 1.4, Temporary Water Quality Standards have been adopted for certain stream segments near the Blackfoot River headwaters in conjunction with ongoing mine reclamation activities in the area. The temporary standards supersede the B-1 classification standards for the period that the temporary standards are in effect (2000 to 2008). However, water quality restoration targets and TMDL development in these stream segments are based on the B-1 standards since these are the standards the water bodies will ultimately be required to meet.

In addition to the numeric water quality criteria included in WQB-7, general water quality standards for B-1 classification waters are included in various sections of the Administrative Rules of Montana. General water quality standards utilized in development of this water quality restoration plan, along with certain definitions, are included in Appendix A.

1.2.3 Stream Sediment Metals Criteria

Similar to the water column, elevated metals concentrations in stream sediments can negatively impact aquatic life support (and other beneficial uses) in surface water, and thus contribute to water quality impairment. Elevated metals concentrations in stream sediments can also be an indicator of more severe water quality impacts further upstream. Unlike surface waters, no standards or criteria currently exist specifying allowable metals concentrations in sediments, although there are published guidance values denoting potentially harmful conditions for aquatic biota (Jones et al, 1997; Long and Morgan, 1990).

As part of the water quality restoration planning process, sediment chemistry results in a given stream can be compared to published guidance values, which is the approach taken in this document. Where water column chemistry and/or biological results show an impairment condition, then the sediment chemistry results will be used to help define the level of impairment and metals of concern. If the water column chemistry (both high and low flow conditions) and biological results (both periphyton and macroinvertebrate) do not indicate an impairment condition, then it can be concluded that the water body is not impaired due to metals even if some sediment chemistry metals are greater than published guidance values. The exception is where sediment chemistry metals are greater than published guidance values and potential upstream metals sources indicate the possibility of impairment conditions further upstream in the watershed. Under this scenario, it may be concluded that more data is needed in the upper segments of the watershed if beneficial use determinations have not yet been made regarding

potential impacts from metals. These beneficial use determinations can be made by collecting data further upstream closer to the potential sources of metals. The additional upstream data collection will need to include biological (both periphyton and macroinvertebrate) and water column chemistry sampling prior to making a full support conclusion relative to metals impacts on aquatic life. Sediment chemistry sampling may no longer be necessary for making the beneficial use determination depending on how far upstream the sampling occurs and where the sampling is performed relative to the potential sources of metals loading. The amount of additional sampling needed will be based on how much the sediment metals concentrations exceed published guidance values, the estimated severity of potential upstream loading sources, watershed characteristics, and the availability of relevant data throughout the watershed for making beneficial use determinations.

MDEQ has initiated development of a total metals index (TMI) screening level criteria for metals in sediment that accounts for possible cumulative effects of multiple metals within sediments. This sediment metals TMI utilizes some of the above referenced published guidance values denoting potentially harmful conditions for aquatic biota. Until a more formalized TMI or other approach is developed, MDEQ will continue to apply the above referenced approach for assessing beneficial use impacts from metals in sediments within the Blackfoot Headwaters TMDL Planning Area.

1.3 303(d) Listing and Pollutants of Concern

An impaired water body is a water body that does not meet state water quality standards and does not fully support all designated beneficial uses for that water body. Section 303 of the Clean Water Act requires states to submit a list of impaired water bodies (streams, lakes, wetlands) to the U.S. Environmental Protection Agency (EPA) every two years. The 303(d) List identifies which beneficial uses are impaired and indicates the probable causes (i.e., the pollutant such as metals) and the probable sources of the impairment (such as mining or roads). Table 1-1 includes 303(d) listing information for water bodies within the Blackfoot Headwaters TMDL Planning Area that have been listed as impaired due to metals and/or other causes.

Montana's 2002 303(d) List is the most current EPA-approved list and is based on a higher level of scientific analyses in comparison to past 303(d) Lists. A ruling by the U.S. District Court (CV97-35-M-DWM) on September 21, 2000 stipulates that the state of Montana must complete "all necessary TMDLs for all waters listed as impaired or threatened on the 1996 303(d) List." In other words, the court ruling requires a TMDL be developed for each pollutant (probable cause) and water body combination identified in Table 1-1 for the 1996 list or any subsequent lists. The exception is where supplemental data and assessment work has determined that the water body is in fact not impaired for the pollutant of concern.

Willow Creek from Sandbar Creek to the mouth was listed for metals in 1996 but not in 2002. This stream segment is not treated as an impaired water body, although a restoration strategy is developed for Willow Creek based on TMDL development and implementation in Sandbar Creek, and efforts to ensure that there are no significant metals sources in the upper part of the Willow Creek drainage. The Blackfoot River from the Landers Fork to Nevada Creek was on the 1996 list for metals, but not on the 2002 list for metals. Based on a review of past and recent

high flow water quality data, and documented upstream and tributary metals loading sources, metals TMDLs have been developed for this river segment in conjunction with TMDL development for the upstream segment above Landers Fork. Mike Horse Creek was not on the 1996 or any subsequent lists. Significant impairment conditions in this tributary to Beartrap Creek has led to a decision to develop metals TMDLs for this stream in conjunction with TMDL development for Beartrap Creek. MDEQ files and future 303(d) lists will be updated to reflect the TMDL development and related impairment determinations discussed above.

Based on information provided in Table 1-1 and the above discussion, water bodies in need of TMDL development and water quality restoration planning for metals-related impairment are listed in Table 1-2. These include Beartrap Creek from the confluence with Mike Horse Creek to the mouth (0.5 miles), the lower approximate 0.6 miles of Mike Horse Creek, the Blackfoot River from its headwaters to the confluence with Landers Fork (16.4 miles), the Blackfoot River from Landers Fork to the confluence of Nevada Creek (48.3 miles), Sandbar Creek from the confluence of three tributary forks to the mouth (1.6 miles), and Poorman Creek from headwaters to mouth (14.0 miles). These water bodies are identified on Figure 1-2, with the water bodies included on the 2002 303(d) list highlighted as “metals listed stream segments”.

1.3.1 Evidence of Metals-Related Impairment

Available water quality data from the metals-listed stream segments show that concentrations of certain metals exceed the numeric water quality criteria in the Blackfoot River above Landers Fork, the Blackfoot River below Landers Fork to Nevada Creek, Beartrap Creek, Mike Horse Creek, Sandbar Creek, and a tributary to Poorman Creek. Specific metals exceeding the numeric water quality criteria in one or more of the stream segments include aluminum, cadmium, copper, iron, lead, manganese, and zinc.

Sediment chemistry data also supports the metals impairment determinations for Poorman Creek, Sandbar Creek, Beartrap Creek, Mike Horse Creek, and the Blackfoot River upstream of Landers Fork. Sediment metals concentration from these stream segments significantly exceed published guidance levels denoting metals concentrations believed to be harmful to aquatic life.

In addition to the water and sediment chemistry data, biological data support the impairment determinations for most of the metals-impaired water bodies. Periphyton (attached algae) samples collected in 2001 indicate probable metals contamination at several sites with high proportions of abnormal diatom cells, indicating moderate to severe impairment. These sites include the upper Blackfoot River near Flesher Pass Road, the upper Blackfoot River above the Landers Fork, two upper locations along Poorman Creek, and both sampling locations along Sandbar Creek (Bahls, 2001).

Table 1-1 Blackfoot Headwaters TMDL Planning Area 1996, and 2002 303(d) List of Impaired Waters, Probable Causes and Sources, and Years Listed for Metals.

WATERBODY/ WATERBODY NO.	LIST	PROBABLE CAUSE(S)	PROBABLE SOURCE(S)	YEAR(S) LISTED FOR METALS¹
Blackfoot River (Headwaters to Landers Fork) MT76F001-010	1996	Metals, Nutrients, Other Inorganics, Siltation	Agriculture, Harvesting, Restoration, Residue Management, Mine Tailings, Resource Extraction, Subsurface Mining	1996, 1998, 2000, 2002
	2002	Metals, Habitat Alterations	Silviculture, Resource Extraction, Acid Mine Drainage, Abandoned Mining, Habitat Modification (other than hydromodification), Bank Modification/Destabilization	
Blackfoot River (Landers Fork to Nevada Cr) MT76F001-020	1996	Metals, Siltation, Suspended Solids	Agriculture, Natural Sources, Resource Extraction, Silviculture	1996, 1998
	2002	Other Habitat Alterations, Siltation	Agriculture, Silviculture	
Willow Cr MT76F002-020	1996	Metals	Resource Extraction, Subsurface Mining	1996, 1998
	2002	Bank Erosion, Habitat alteration, Siltation	Agriculture, Grazing, Habitat Modification, Bank Modification, Highway Maintenance and Runoff	
Poorman Cr (headwaters to mouth) MT76F002-030	1996	Metals, Habitat Alteration, Siltation	Agriculture, Canalization, Dredge Mining, Irrigated Crop Production, Logging Road Construction/ Maintenance, Natural Sources, Resource Extraction, Streambank Modifications/ Destabilization	1996, 1998, 2000, 2002
	2002	Dewatering, Flow Alteration, Metals, Habitat Alterations, Riparian degradation, Siltation	Silviculture, Logging roads, Construction, Resource Extraction, Abandoned Mining	
Beartrap Cr (Mike Horse Cr to mouth) MT76F002-040	1996	Metals	Mill Tailings, Resource Extraction, Subsurface Mining	1996, 1998, 2000, 2002
	2002	Metals	Resource Extraction, Mill Tailings	
Sandbar Cr (from forks to mouth) MT76F002-060	1996	Metals	Resource Extraction Subsurface Mining	1996, 1998, 2000, 2002
	2002	pH, Copper, Metals, Habitat Alterations, Siltation	Resource Extraction, Acid Mine Drainage, Abandoned Mining, Highway Maintenance and Runoff	
Arrastra Cr (headwaters to mouth) MT76F002-070	1996	Flow Alteration, Habitat Alterations, Siltation	Agriculture, Highway/ Road/ Bridge Construction, Natural Sources, Range Land	None
	2002	Habitat Alterations, Siltation	Agriculture, Habitat Modifications, Shoreline Modification, Highway Maintenance and Runoff	

1 – The 1996 and 1998 lists are very similar to each other, and the 2000 and 2002 lists are very similar to each other

Table 1-2 Water Bodies in Need of Restoration Plan for Metals.

Water Body	Stream Segment Number	Stream Miles	Beneficial Uses not Fully Supported	Pollutants of Concern¹
Blackfoot River from Landers Fork to confluence of Nevada Creek	MT76F001-020	48.3	Aquatic life Cold water fishery	Aluminum, Cadmium, Iron, Zinc
Blackfoot River from headwaters to confluence with Landers Fork	MT76F001_010	16.4	Aquatic life Cold water fishery Drinking water supply	Cadmium, Copper, Iron, Lead, Manganese, Zinc
Beartrap Creek (Mike Horse Cr to mouth)	MT76F002-040	0.5	Aquatic life Cold water fishery Drinking water supply	Cadmium, Copper, Iron, Lead, Manganese, Zinc
Mike Horse Creek	Number not assigned yet	0.6	Aquatic life Cold water fishery Drinking water supply	Aluminum, Cadmium, Copper, Iron, Lead, Manganese, Zinc.
Sandbar Creek (from forks to mouth)	MT76F002-060	1.6	Aquatic life Cold water fishery Drinking water supply	Aluminum, Copper, Iron, Manganese
Poorman Creek (headwaters to mouth)	MT76F002-030	14.0	Aquatic life Cold water fishery	Cadmium, Copper, Lead

1- Based on recent (1996-2002) water and sediment chemistry data

Macroinvertebrate analyses also suggest metals contamination at several sites in the Planning Area. Samples collected during the late 1980s (Ingman et al. 1990, McGuire 1991) indicate a paucity of overall taxa richness and especially mayfly richness at the upstream stations in the vicinity of the Upper Blackfoot Mining Complex. Similarly, the most recent macroinvertebrate samples from 2001 had no mayfly taxa at upper Blackfoot River site and the lower Sandbar Creek below historic mining activities (Bollman, 2002).

Analyses of metals in fish tissues provide further evidence of metals-related impairment. Comparisons of metals accumulating in tissues of macroinvertebrates indicated a trend for greater concentrations of cadmium in insects with increasing proximity to the headwaters (Moore, 1990). Similarly, concentrations of metals in fish livers showed a statistically significant trend for decreasing metals from the headwaters to the mouth (Confluence et al., 2002). This biological data, in conjunction with the water column and stream sediment metals concentration data, confirm that the stream segments listed as impaired for metals in the Planning Area do not fully support all beneficial uses and thus are impaired.

1.4 Upper Blackfoot Mining Complex

The predominant source of metals-related water quality impairment in the Blackfoot Headwaters Planning Area is the Upper Blackfoot Mining Complex (UBMC). The UBMC, also referred to as the Heddleston Mining District, is an area of historic mining activity near the Blackfoot River

Headwaters (Figure 1-2). The UBMC is comprised of several individual historic mines including the Mike Horse, Anaconda, Edith, Paymaster, Carbonate, Capital and Consolation mines, as well as a number of smaller mineral developments. Mining activities began in the late 1800s with the discovery of silver, gold, lead and zinc-bearing ore, with sporadic mine development occurring up until the mid 1950s. The majority of mining activity occurred at the Mike Horse Mine during the 1920s and early 1940s. In this report, the UBMC refers to the area of historic mining activity at the Blackfoot River headwaters (upstream of Pass Creek, Figure 1-2), although no formal legal boundaries have been applied to the UBMC.

In 1939, a 150 ton-per-day flotation mill was built at the Mike Horse Mine, and in 1941 a tailings impoundment was constructed in Beartrap Creek drainage. The tailings impoundment received mill tailings from the Mike Horse Mill from 1941 until 1955 when the Mike Horse Mine was shut down. In June 1975, a combination of heavy rains and blockage of a surface water diversion caused the tailings dam to breach, releasing an estimated 100,000 tons of native soils and mill tailings to Beartrap Creek and the upper Blackfoot River. The tailings dam breach, in conjunction with historic mining activities at the UBMC, have resulted in significant impacts to the environment, including the release of acid mine drainage and metals to area surface waters, and loss of aquatic and riparian habitat. Significant dam repairs were made in 1975 and 1980 following the breach (Dames and Moore, 1975 and 1980).

In 1993, ASARCO Incorporated and ARCO (identified in 1992 by the State of Montana as liable parties for mining-related contamination at the UBMC) initiated mine reclamation activities at the UBMC. From 1993 to 1998, reclamation activities focused primarily on historic mining impacts located on private property (patented mining claims owned by Asarco). Activities included removal of mine waste rock and mill tailings from drainage bottoms and placement in three engineered repositories, regrading and revegetation of disturbed areas, treatment of mine drainage from two historic adits (the Mike Horse and Anaconda mine adits) through a constructed wetlands-based water treatment system, and construction of a second wetlands-based water treatment system for treatment of mine drainage from the historic Paymaster Mine adit.

1.4.1 Temporary Water Quality Standards

In 1999, Asarco petitioned the Montana Board of Environmental Review for adoption of Temporary Water Quality Standards for three stream segments at the UBMC. The temporary standards were sought, in part, so that mine reclamation activities could continue on public lands. The three stream segments include a portion of Mike Horse Creek, a portion of Beartrap Creek, and a portion of the upper Blackfoot River. In accordance with MCA 75-5-312(2), Asarco prepared a support document and Implementation Plan (Hydrometrics, 1999, 2000) for use by the Board and MDEQ in considering the temporary standards petition (see Appendix B). The Implementation Plan identifies documented sources of metals-related water quality impairment to the three stream segments, and lists remedial alternatives for each identified source.

In May of 2000 the Board approved adoption of the temporary water quality standards with the standards taking affect in June of 2000. The standards are scheduled to expire on May 31, 2008 but may be extended up to two years to allow for completion of access agreements to the affected public property (ARM 17.30.630(2)).

1.4.2 Status of UBMC Mine Reclamation Program

Phase I of Asarco's mine reclamation program (1993-1998) focused primarily on mining disturbances located on private property (patented mining claims). With adoption of temporary water quality standards and completion of land access agreements, mine reclamation efforts will be expanded to include mining-related impacts on public lands at the UBMC. Specific reclamation issues to be addressed in the future include, but are not limited to: environmental impacts from, and stability of, the Mike Horse Tailings Impoundment; concentrated mine wastes located along lower Mike Horse Creek; and fluvial tailings located along the Beartrap Creek/Upper Blackfoot River floodplain. The Implementation Plan prepared by Asarco in support of their petition for temporary standards provides a synopsis of remaining sources of metals loading to the affected streams, and an eight-year schedule for remediation of all identified sources. The Temporary Standards Implementation Plan is included as Appendix B of this document.

Asarco and the U.S. Forest Service recently entered into an Administrative Order on Consent (AOC) for development of an Engineering Evaluation/Cost Analysis (EE/CA) by Asarco. The purpose of the EE/CA is to evaluate removal action requirements and alternatives designed to prevent, mitigate, or otherwise respond to or remedy any release or threatened release of hazardous substances on National Forest lands at the UBMC. Reclamation activities performed under the EE/CA will be conducted as a Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) action under supervision of the U.S. Forest Service. Activities performed under the Temporary Standards Implementation Plan will be supervised by MDEQ. Upon completion of the EE/CA, mine reclamation activities will resume at the UBMC in accordance with the EE/CA findings and the Implementation Plan schedule (Appendix B).

1.5 Seasonality and Margin of Safety

All TMDLs must consider seasonality and also incorporate a margin of safety.

1.5.1 Seasonality

Seasonality addresses the need to ensure year round beneficial use support. The TMDL should include a discussion of how seasonality was considered for assessing loading conditions and for developing the target, the TMDL, the allocation scheme, and/or the pollutant controls. As with most metals TMDLs, seasonality plays a critical role due to varying metals loading pathways and varying water hardness during high and low flow conditions. The initial rising limb of the hydrograph during spring runoff is also considered for some water bodies. Loading pathways associated with overland flow and erosion of metals contaminated soils and wastes tend to be the major cause of elevated metals concentrations during high flows, with the highest concentrations and metals loading typically occurring during the rising limb of the hydrograph. Loading pathways associated with ground water transport and/or adit discharges tend to be the major cause of elevated metals concentrations during low or baseflow conditions. Hardness tends to be lower during higher flow conditions, thus leading to lower water quality standards for some metals during the runoff season. Seasonality is addressed in this document as follows:

- Metals impairment and loading conditions are evaluated at high and low flow conditions, and, in some situations, for early spring runoff conditions corresponding to the onset of the rising limb of the hydrograph.
- Metals TMDLs incorporate streamflow as part of the TMDL equation.
- Metals targets apply year round, with monitoring criteria for target compliance developed to address seasonal water quality extremes associated with loading and hardness variations.
- Example targets, TMDLs and load reduction needs are developed for high and low flow conditions.

1.5.2 Margin of Safety

The margin of safety may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (EPA, 1999). The margin of safety is addressed in several ways as part of this document:

- Seasonality effects are taken into account as discussed above.
- Compliance with targets, refinement of load allocations, and, in some cases, impairment determinations are all based on an adaptive management approach that commits to future monitoring and assessment for updating planning and implementation efforts.
- There are built in margins of safety within existing numeric water quality standards.
- The most protective numeric standard (typically the chronic aquatic life support criteria) is used to set target conditions where multiple numeric standards are applicable.
- In addition to numeric water column criteria, additional beneficial use support targets include biota criteria associated with periphyton and macroinvertebrates.
- Sediment chemistry targets are developed to help ensure full support of aquatic life and cold water fishery.
- A relatively conservative approach is used for identifying impaired water bodies, thus leading to TMDL development for Poorman Creek and the lower segment of the Blackfoot River from Landers Fork to Nevada Creek. A conservative approach is also taken for Willow Creek whereby additional data is needed prior to assuming that no metals TMDLs are required.
- Load allocations are applied to tributary drainages to the Blackfoot River to ensure that the tributaries meet B-1 standards. These reductions, in some situations, may provide loading reductions above and beyond the minimum loading reductions needed to satisfy water quality standards and target conditions in the Blackfoot River.
- The above tributary load allocation approach helps ensure timely TMDL development for tributary watersheds in need of TMDL development but not yet identified as impaired water bodies. This furthers efforts to support beneficial uses throughout the watershed.

1.6 Restoration Plan Organization

Sections 2 through 5 of this document describe the individual water bodies and associated TMDL development for metals impairment conditions. Section 2 is the restoration plan for

Sandbar Creek and Willow Creek and includes a discussion of available water quality data, a summary of metals-related impairment conditions, identification and description of metals loading sources, and water quality restoration targets, TMDLs and load allocations. Section 3 provides this same information for Poorman Creek drainage, Section 4 for Beartrap Creek drainage including Mike Horse Creek, and Section 5 addresses the Blackfoot River segments both upstream and downstream of Landers Fork. Section 6 outlines a general restoration strategy for implementation of this TMDL/Water Quality Restoration Plan. The restoration strategy identifies regulatory considerations and potential regulatory programs under which impairment sources may be addressed, and possible funding sources for implementing restoration activities. Section 6 also includes recommendations for additional environmental monitoring intended to provide information necessary for making beneficial use support decisions in certain drainages lacking the required data, for more detailed source area delineation and load allocation, and to support restoration planning and reclamation design to mitigate metals loading sources.

Supporting information is provided in the document appendices. Appendix A provides a general description of the TMDL process, including the definition and purpose of a TMDL, TMDL calculation methods, and special considerations for TMDL development in the Blackfoot Headwaters TMDL Planning Area. Readers likely will benefit by reviewing Appendix A prior to reading Sections 2 through 5. Appendix B contains the Upper Blackfoot Mining Complex Temporary Standards Implementation Plan. This Implementation Plan provides additional detail on the predominant source of metals-related water quality impairment in the Planning Area. Appendix C includes available metals-related water quality data from the drainages of interest. This data is used in the development of the TMDLs and in water quality restoration planning. Appendix D provides supporting information for the restoration strategy and Appendix E includes information on characterization of sources of metals-related impairment. Appendix F is the response to public comment section.

SECTION 2.0

RESTORATION PLAN FOR SANDBAR CREEK AND WILLOW CREEK

The lower 1.6 miles of Sandbar Creek (from the confluence of three tributary forks downstream to the mouth, Figure 2-1) is listed as impaired on the 1996 and 2002 303(d) lists with metals being the probable cause of impairment on the 1996 list, and copper, metals, pH, habitat alterations and siltation listed as probable causes of impairment on the 2002 list (Table 1-1). Sections 2.1 through 2.4 summarize the available water quality and other data for metals, and identify the level of metals-related impairment and potential metals-loading sources in the Sandbar Creek drainage. Water quality restoration targets are developed for those metals found to contribute to water quality impairment in Sandbar Creek. Based on the restoration targets, example TMDLs are presented for high flow and low flow conditions as documented during previous sampling events. Load allocations are then presented based on the restoration targets and example TMDL requirements.

Sandbar Creek flows into Willow Creek and contributes to potential impairment conditions in Willow Creek. Section 2.5 provides a discussion on potential impairment conditions and water quality restoration plan components for Willow Creek, similar to the Sandbar Creek approach in Sections 2.1 through 2.4.

2.1 Available Water Quality Data for Sandbar Creek

Current water quality data from Sandbar Creek drainage includes analytical results from seven surface water samples collected between June 1996 and October 2002. Four samples were collected from lower Sandbar Creek near the National Forest boundary (site designations SCSW-1, C03SNDBC02, and 4229SA01 on Figure 2-1). Two water samples were collected from the main Sandbar Creek channel immediately downstream of the confluence of three main tributary forks (site designations SCSW-2 and C03SNDBC01). One sample has been collected on the main Sandbar Creek channel upstream of the tributary forks (site SCSW-3). Four of the seven samples were collected in June during spring runoff conditions, although two samples from June 2001 were taken at relatively lower flows at the latter part of the falling limb of the hydrograph. Three samples were collected in October during low flow conditions. All sampling sites are shown on Figure 2-1 and the sampling schedule and analytical parameters listed in Table 2-1. The complete water quality database is included in Appendix C.

Table 2-1 Summary of Current Available Water Quality Data from Sandbar Creek Drainage.

Stream Segment	Site Designations	Date Sampled	Sampled By	Analyses
Upper Sandbar Creek	SCSW-3	10/02	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC
Sandbar Ck below Forks	C03SNDBC01	6/01	MDEQ	Metals, SO ₄ , hard., flow, pH/SC
	SCSW-2	10/02	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC
Lower Sandbar Ck	4229SA01	6/96	MDEQ	Metals, SO ₄ , hard., flow, pH/SC
	C03SNDBC02	6/01	MDEQ	Metals, SO ₄ , hard., flow, pH/SC
	SCSW-1	6/02; 10/02	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC

Site locations shown on Figure 2-1.

SO₄- Sulfate; hard - hardness as CaCO₃; SC- Specific Conductance

2.2 Sandbar Creek Drainage Impairment Conditions

2.2.1 Water Quality Data

Table 2-2 provides a summary of water quality exceedences in Sandbar Creek, relative to applicable numeric water quality standards for high flow and low flow conditions. Water quality data collected in June 1996, 2001 and 2002 are used to represent higher flow conditions, while data collected in October 2002 represent low flow (baseflow) conditions. The 1996, 2001 and 2002 data were compared to the State of Montana human health, chronic aquatic life, and acute aquatic life numeric criteria included in WQB-7 (MDEQ, 2001b).

The June water quality data show that metals concentrations in Sandbar Creek routinely exceed applicable B-1 classification standards for copper, aluminum and iron under high flow conditions (Table 2-2). Copper concentrations have exceeded the chronic aquatic criteria in all four high flow samples collected to date and the acute aquatic criteria in three of the four samples. Iron concentrations exceed the domestic use narrative standard guidance value of 300 µg/L in two of the four high flow samples while aluminum exceeded the chronic aquatic criteria in the only sample analyzed for aluminum.

October 2002 water quality data from three sites (SCSW-1, SCSW-2, SCSW-3, Figure 2-1) represent the only low flow water quality data available from Sandbar Creek. The October data show that copper, iron and manganese exceeded applicable water quality criteria at downstream site SCSW-1, while there were no exceedences at the two upstream sites. The copper concentration at SCSW-1 exceeded both the chronic and acute aquatic life criteria, and iron and manganese concentrations exceeded the narrative standard guidance value.

In addition, fine-grained orange precipitates cover the Sandbar Creek streambed in the lower two-thirds of the listed stream segment. Based on appearance, the deposits are believed to consist primarily of iron-hydroxide precipitates and may impede aquatic life support in Sandbar Creek.

Although pH is included on the 2002 303(d) list as a cause of impairment in Sandbar Creek, current data does not support this listing. Of the seven water samples collected from the drainage between 1996 and 2002, pH values have ranged from 6.0 to 8.66 and averaged 7.59. Also, downstream trends in pH as measured in June 2001 and October 2002 show that stream pH values increase in a downstream direction. This suggests that identified sources of water quality impairment in the drainage (historic mining-related disturbances) do not cause excessive variations in pH values and thus do not support an impairment determination for pH. For this reason, TMDL development is not pursued for pH in Sandbar Creek.

2.2.2 Streambed Sediment Metals Concentrations

One stream sediment sample was collected from Sandbar Creek sampling site C03SNDBC01 in June 2001 (Figure 2-1). The sediment sample consisted of fine-grained material (<63 µm) and was analyzed for total metals concentrations. Sediment analytical results are shown in Table 2-3.

Table 2-2 Sandbar Creek Drainage Seasonal Metals Impairment Summary.

Metal	Season*	N	Concentration Range µg/L	Exceedence Summary	Water Quality Standards References
Aluminum (dissolved)	High Flow	1	110	<ul style="list-style-type: none"> Single dissolved measurement exceeds 87 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i)-WQB-7 17.30.637(1)(d)
	Low Flow	3	<50 to <50	<ul style="list-style-type: none"> Consistently less than 87 µg/L chronic aquatic life criteria at all three sites sampled in 10/02. 	
Cadmium	High Flow	4	<0.2 to <0.1	<ul style="list-style-type: none"> Consistently less than hardness-based chronic and acute aquatic life criteria and 5 µg/L human health standard 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	3	<0.1 to <0.1	<ul style="list-style-type: none"> Consistently less than hardness-based chronic and acute aquatic life criteria and 5 µg/L human health standard 	
Copper	High Flow	4	5 to 13	<ul style="list-style-type: none"> Exceeds hardness-based chronic aquatic life criteria in 4 of 4 measurements and acute aquatic life criteria in 3 of 4 measurements. Consistently less than 1,300 µg/L human health standard. 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	3	1 to 22	<ul style="list-style-type: none"> Exceeds hardness-based chronic aquatic and acute aquatic life criteria at downstream site SCSW-1. Consistently less than 1,300 µg/L human health standard. 	
Iron	High Flow	4	70 to 580	<ul style="list-style-type: none"> Greater than 300 µg/L guidance level in 2 of 4 measurements. Consistently less than 1,000 µg/L aquatic life criteria. 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d) 17.30.637(1)(a) 17.30.601
	Low Flow	3	<30 to 1,020	<ul style="list-style-type: none"> Greater than 300 µg/L guidance level and 1,000 µg/L aquatic life criteria at downstream site SCSW-1. No exceedences at two upstream sites. 	
Lead	High Flow	4	<1 to <2	<ul style="list-style-type: none"> Consistently less than 15 µg/L human health standard and hardness-based chronic and acute aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	3	<2 to <2	<ul style="list-style-type: none"> Consistently less than 15 µg/L human health standard and hardness-based chronic and acute aquatic life criteria 	
Manganese	High Flow	3	<5 to 30	<ul style="list-style-type: none"> Consistently less than 50 µg/L guidance level 	17.30.623(2)(h)(i) - WQB-7 17.30.601
	Low Flow	3	<10 to 120	<ul style="list-style-type: none"> Exceeds 50 µg/L guidance level at downstream site SCSW-1. 	
Zinc	High Flow	4	7 to <10	<ul style="list-style-type: none"> Consistently less than 2,100 µg/L human health standard and hardness-based chronic and acute aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	3	10 to 20	<ul style="list-style-type: none"> Consistently less than 2,100 µg/L human health standard and hardness-based chronic and acute aquatic life criteria 	

High flow data includes samples from 1 site in June 1996, 2 sites in June 2001 and 1 site in June 2002. Low flow data includes October 2002 samples from SCSW-1, SCSW-2 and SCSW-3.

Evaluation of exceedences based on total recoverable fraction (except for aluminum which is based on dissolved fraction).

n- number of measurements

**Table 2-3 Stream Sediment Metals
Concentrations from Sandbar Creek
Sampling Site C02SNDBC01.**

Site C03SNDBC01	Concentration mg/Kg
Aluminum	17300
Arsenic	54
Cadmium	8
Copper	685
Iron	33200
Lead	166
Manganese	2310
Nickel	31
Zinc	685

Sample collected by MDEQ in June 2001

Metals concentrations are total (EPA Method 3050)

Site locations shown on Figure 2-1.

Analytical results indicate the sediment sample contained elevated concentrations of a number of metals. Concentrations of some metals, including cadmium, copper, iron, manganese, lead, arsenic, and zinc, are significantly greater than published guidance levels denoting potentially harmful conditions for aquatic biota associated with sediment metals concentrations (Jones et al., 1997; Long and Morgan, 1990). This indicates that metals concentrations in stream sediments are likely impacting aquatic life support (and possibly other beneficial uses) in Sandbar Creek and need to be considered within this water quality restoration plan.

2.2.3 Impairment Determination for Sandbar Creek

The above discussions on water quality, sediment chemistry, along with the biological data discussed in Section 1.3.1, sufficiently justify the metals impairment determination for the listed portion of Sandbar Creek and the need for TMDL development for multiple metals. TMDL development for pH is not necessary since the data does not indicate an impairment condition.

2.3 Sandbar Creek Source Characterization

2.3.1 Metals Source Inventory

Historic mining disturbances comprise the main sources of metals loading to Sandbar Creek. Two abandoned mines have been identified in the Sandbar Creek drainage bottom through review of USBM and MDEQ abandoned mine databases, and a site reconnaissance. One of the mines is located on the listed stream segment between sampling sites SCSW-1 and SCSW-2 (Figure 2-1). The second (smaller) mine is located upstream of the listed stream segment between sampling sites SCSW-2 and SCSW-3. The mines are relatively small in size with each consisting of a collapsed adit and associated mine waste dump. Due to their proximity to the active stream channel, both mine dumps are potential sources of metals loading to Sandbar Creek. A metals loading analysis performed on Sandbar Creek and included in Appendix E supports this finding. The upstream extent of the iron hydroxide precipitates coating the Sandbar

Creek channel closely coincides in location with the downstream mine. Neither of the collapsed adits shows evidence of current or past water seepage or flow.

In addition to the two mines, there is a section of road that appears to be constructed in part from mine waste material. The road is located a short distance downstream of the uppermost abandoned mine as shown on Figure 2-1. Based on the close proximity of the road to the active stream channel, the road fill material may be a source of metals loading to the creek.

2.4 Sandbar Creek Restoration Targets, TMDLs and Load Allocations

Water quality restoration targets are established below for high flow and low flow conditions in Sandbar Creek. The restoration targets are an integral component of the metals TMDLs and are sometimes referred to as the TMDL endpoints. The restoration targets for specific metals represent the maximum metals concentrations that may occur within Sandbar Creek without exceeding water quality standards. As such, these restoration targets are identical to the B-1 classification numeric water quality standards and represent primary water quality goals of the TMDL process. Additional restoration targets based on sediment toxicity, biota measures, and stream deposits are also presented as an additional margin of safety to ensure full support of aquatic life beneficial uses.

Based on the restoration targets, TMDLs are presented below for the metals that currently exceed restoration targets. Following TMDL development, load allocations are discussed for various source areas in the drainage (see Appendix A for discussion of overall process).

2.4.1 Metals Restoration Targets

Table 2-4 provides water quality restoration targets for those metals that exceed B-1 classification water quality standards in Sandbar Creek, including copper, iron, manganese and aluminum (Section 2.2). The water quality-based restoration targets for aluminum and copper are based on the chronic aquatic life criteria with the copper target adjusted for water hardness (Appendix A). Hardness values used in calculating the targets are based on actual measured values as specified in Table 2-4. Because it is unknown what the actual hardness value will be under restoration conditions, the target values listed in Table 2-4 for these metals represent estimated values at the various flow conditions. The actual targets will be based on in-stream hardness values as measured at the time of sampling. Appendix A provides an example of the hardness adjustment equation for chronic aquatic life support standards.

Basing restoration targets on the chronic aquatic criteria for copper and aluminum will ensure that other numeric criteria (human health, acute aquatic life) are met since the chronic criteria are the most stringent (lowest concentration). The restoration targets for iron and manganese are based on the 300 µg/L and 50 µg/L guidance values for drinking water use support in WQB-7 (MDEQ, 2001b). Iron also has an upper limit target of 1000 µg/l based on the chronic criteria for aquatic life support.

Compliance for the water quality targets will be based on high and low flow water quality data, with no more than one measurement of the concentration for a particular metal exceeding the chronic criteria by more than 10%. This approach is consistent with MDEQ guidance for

making beneficial use support determinations (MDEQ, 2002). In evaluating compliance with the iron and manganese drinking water use targets, consideration should be given to the level and frequency of exceedences, and whether or not the exceedences interfere with the uses specified in the surface water quality standards (ARM 16.30.623). Appendix A provides additional discussion for evaluating compliance with the iron and manganese targets.

Based on the metals loading sources specific to Sandbar Creek drainage (historic mine waste), the high flow water quality data will need to be collected during the rising limb of the hydrograph, and the low flow water quality data is to be collected at or near base flow conditions. At a minimum, monitoring locations SCSW-1 and SCSW-2, or comparable sites (Figure 2-1) will be used for determining compliance with targets (see Section 6.3, Monitoring Strategy).

Table 2-4 Water Quality Restoration Targets for Metals in Sandbar Creek.

POLLUTANT	TARGET(S)	LIMITING BENEFICIAL USE
Copper ¹	13.2 (low flow) 9.3 ug/l (high flow)	Aquatic Life (chronic) Aquatic Life (chronic)
Iron	300 ug/l 1000 ug/l (all flows) No visible stream bed deposits associated with controllable human sources	Drinking water (domestic use) Aquatic life (chronic) Aquatic life/Aesthetics
Manganese	50 ug/l	Drinking water (domestic use)
Aluminum	87 ug/l (all flows)	Aquatic Life (chronic)
Metals	No metals concentrations in sediments that may impede beneficial uses. Macroinvertebrate and periphyton communities must show no impairment from metals.	Aquatic Life Aquatic Life

Notes: 1. Copper targets are based on hardness values of 40 mg/L during high flow and 55 mg/L at low flow as determined from past sampling results; copper targets will vary with water hardness at any given time (Appendix A).

In addition to the water chemistry-based targets, iron has an additional target of no visible streambed deposits resulting from human causes. Another target is that metals concentrations in sediments cannot impede beneficial uses, with focus on aquatic life support. This target applies to all metals, either individually or in combination, which may occur at potentially toxic concentrations in stream sediments. Lead and zinc are of special concern given the relatively high levels in sediment chemistry as identified in Table 2-3. Assessment of stream sediment concentrations and beneficial use support conditions will be consistent with the stream sediment screening approach discussed in Section 1.2.3.

As an additional measure of water quality restoration, a target for macroinvertebrate and periphyton communities also applies. These communities must show no impairment from metals as compared to a known reference condition using standard MDEQ protocols (reference Appendix A). The monitoring locations for compliance with the sediment chemistry and biota

targets will be based on the same sampling locations used for water column chemistry target compliance, with the option of using just one location if the one location can provide assurance of beneficial use support.

It is important to note that the above targets represent minimum requirements for metals for protecting beneficial uses identified within Montana's Surface Water Quality Standards, and are based on interpretations of available data presented within this plan. Other regulatory programs with water quality protection responsibilities may impose additional requirements to ensure full compliance with all appropriate local, State and Federal laws.

2.4.2 Metals TMDLs for Sandbar Creek

TMDLs are required for the metals aluminum, copper, iron and manganese since these are the metals contributing to impairment of Sandbar Creek (Section 2.2). As discussed in Appendix A, the TMDLs represent the maximum amount of each metal that a stream can assimilate without exceeding water quality standards. This assimilative capacity is a function of the streamflow rate (dilution capacity), and for some metals, the water hardness (which determines the numeric water quality criteria). Therefore, the TMDL must be designed to be protective of beneficial uses and meet water quality standards under the full range of streamflow and water chemistry conditions anticipated. To achieve this, the metals TMDL is presented as an equation to be used to calculate the maximum allowable load of a specific metal at any time or under any conditions. The TMDL equation is as follows:

Equation 2-1: *Total Maximum Daily Load (lb/day) = (X ug/l)(Y cfs)(0.0054)*

where:

X = the applicable water quality numeric standard (target) in ug/l with hardness adjustments where applicable;

Y = streamflow in cubic feet per second;

(0.0054) = conversion factor

Table 2-5 provides high flow and low flow TMDLs for these metals. These TMDLs were calculated from Equation 2-1, using the average of the three June streamflow measurements from monitoring site SCSW-1 (3.4 cfs) for calculating the high flow TMDLs, and the single low flow measurement from SCSW-1 (0.22 cfs) for the low flow TMDLs. The restoration targets were taken from Table 2-4. The calculated TMDLs represent the maximum load (lbs/day) of each particular metal that the creek can accommodate without exceeding applicable water quality standards for the specified streamflow conditions and restoration targets.

Table 2-5 also lists the load reductions needed to meet the specific high flow and low flow TMDLs based on available water quality and streamflow data. Under low flow conditions, required load reductions include 38% for copper, 71% for iron, and 58% for manganese. Required load reductions for high flow conditions include 21% for aluminum, 34% for copper, and 29% for iron. These required load reductions apply to the specific conditions and restoration targets used in calculation of the example TMDLs.

Table 2-5 Sandbar Creek TMDL and Load Reduction Requirement for Metals at Specified High and Low Flow Conditions – Monitoring Location SCSW-1.

Pollutant	Target (ug/l)	Calculated Low Flow and High Flow TMDLs ¹ (lb/day)	% Load Reduction Required to Meet TMDLs and Targets
Copper	13.2 (low flow) 9.3 (high flow)	0.016 (low flow) 0.38 (high flow)	38% (low flow); 34% (high flow)
Iron	300 (low flow) 300 (high flow)	0.36 (low flow) 12.1 (high flow)	71% (low flow); 29% (high flow)
Manganese	50 (low flow) 50 (high flow)	0.06 (low flow) 2.02 (high flow)	58% (low flow) 0% (high flow)
Aluminum	87 (low flow) 87 (high flow)	0.10 (low flow) 3.52 (high flow)	0% (low flow); 21% (high flow)

1. Example low flow TMDL based on single low flow measurement of 0.22 cfs at SCSW-1 on 10/7/02.
2. Example high flow TMDL based on average of three flow measurements (3.44 cfs) measure in 6/96, 6/01 and 6/02. Restoration Targets from Table 2-4.

Some additional notes concerning the Table 2-5 TMDLs and the target conditions they are intended to satisfy include:

- For iron, the TMDL based on the 300 ug/l drinking water/domestic use support condition is expected to satisfy the additional target of no visible stream bed deposits associated with iron hydroxide precipitates from human causes.
- Based on seasonal and other considerations associated with the iron and manganese drinking water/domestic use support criteria, a higher TMDL may be acceptable for both iron and manganese as long as other target criteria associated with visible stream deposits, sediment toxicity, biota support, and chronic aquatic life criteria are satisfied.
- Meeting the metals TMDLs is expected to satisfy the target associated with potential sediment toxicity for two reasons. First, restoration activities designed to address existing sources of metals (believed to primarily be historic mining-related) should also eliminate the source(s) of elevated metals concentrations in sediments. Secondly, as metals loads in Sandbar Creek are reduced to TMDL levels, fine-grained metals-bearing sediments likely will flush through the system during high flow periods via typical sediment transport processes. As source areas are reclaimed, the displaced sediments will be replaced with fewer and cleaner sediments. The response of sediment chemistry to implementation of the metals TMDLs will be documented through post-implementation sediment testing (Section 6.3).
- Meeting all of the metals TMDLs is expected to eliminate any metals-related impediments to satisfying the target associated with macroinvertebrate and periphyton communities being at full support conditions in comparison to reference conditions.

The metals TMDLs and required load reductions presented in Table 2-5 apply to specific streamflow conditions (and water hardness in the case of copper) used in their calculation. Due to the limited streamflow data available, the degree to which these examples represent typical high flow and low flow conditions in the drainage is unknown. It is possible that TMDLs

calculated from future high flow and low flow data may vary significantly from the examples presented here. Ultimately, the TMDL is the load of a particular pollutant that Sandbar Creek can support without exceeding B-1 water quality standards at any time as determined from Equation 2-1. General information on calculations of TMDLs is included in Appendix A. All available water quality data used in calculations of TMDLs and load reduction requirements are in Appendix C.

2.4.3 Sandbar Creek Load Allocations

A TMDL is the sum of all of the load allocations (for nonpoint sources) plus all of the waste load allocations (for point sources) in a drainage, plus a margin of safety. Because there is no point source discharges subject to the Montana Pollutant Discharge Elimination System permit program in Sandbar Creek drainage, waste load allocations are not required. The margin of safety is addressed implicitly through the use of chronic aquatic standards for calculation of TMDLs under all conditions, incorporation of biologic and sediment restoration targets, development of TMDLs for various flow conditions, and, most importantly, adoption of a monitoring program designed to further quantify metals loading sources, assist in restoration planning, and assess TMDL compliance (Section 6.3). In addition, the numeric water quality criteria used in establishing restoration targets contain built-in margins of safety for protection of beneficial uses. Since no waste load allocations or explicit margins of safety are required, the metals TMDLs for Sandbar Creek drainage consist solely of the nonpoint source load allocations in the drainage.

Based on current information, nonpoint sources of metals impairment potentially requiring load allocations are divided into two categories:

- Category 1: Currently identified sources including the two historic mines and the area of apparent mine waste road fill (Figure 2-1) in addition to any natural background metals loading.
- Category 2: Other potential nonpoint sources not yet identified including additional mining-related disturbances, and other human-caused impacts such as roads.

Table 2-6 includes preliminary load allocations for the nonpoint source categories based on the example TMDL values. At this time, the entire load allocations for aluminum, copper, iron and manganese are allocated to the Category 1 sources. This assumes that no additional significant metals loading sources are present in the drainage and that the restoration targets can be met by addressing Category 1 sources only.

Section 6 describes a water monitoring strategy designed to further evaluate potential sources of metals loading in the drainage, including possible natural background sources. The monitoring plan also addresses post-implementation monitoring requirements intended to assess the effectiveness of restoration activities and compliance with the TMDL goals as required in MCA 75-5-703(7). If future monitoring identifies additional sources, the preliminary load allocations in Table 2-6 will need to be adjusted accordingly as part of a phased allocation approach. Ultimately, the load allocation will be driven by attainment of the B-1 classification-based water quality targets listed in Table 2-4.

Table 2-6 Preliminary Metals Load Allocations for Sandbar Creek Drainage.

METAL	TMDL lb/Day	ALLOCATIONS		Margin of Safety
		Identified Non-Point Sources ¹ (Category 1)	Possible Other Non-Point Sources ² (Category 2)	
Copper	High Flow-.38 Low Flow-.016	0.38 0.016	No allocation at this time	Implicit MOS applied through conservatism in TMDL calculation process and required post-implementation monitoring to assess performance of restoration actions.
Aluminum	High Flow-3.52 Low Flow- 0.10	3.52 0.10	No allocation at this time	
Iron	High Flow-12.1 Low Flow- 0.36	12.1 0.36	No allocation at this time	
Manganese	High Flow-0.06 Low Flow-2.02	0.06 2.02	No allocation at this time	

1- Includes two mine dumps and apparent mine waste in road fill as described in Section 2.3 and shown on Figure 2-1, and natural background loading

2- Includes additional human-caused nonpoint sources, which may be identified through future monitoring. If a load allocation is required for additional sources in the future, then the Category 1 load allocation for Identified Non-Point Sources must be reduced accordingly.

2.5 Willow Creek Restoration Plan

2.5.1 Metals Data and Sources

Sandbar Creek flows into Willow Creek, which is a tributary to the Blackfoot River (Figure 2-1). The portion of Willow Creek from Sandbar Creek to the mouth was listed as impaired for metals on the 1996 303(d) list, and was listed as impaired for bank erosion, habitat alterations, and siltation on the 2002 303(d) list (Table 1-1). The more recent listing did not include metals because water quality sample results from June 2001 (near the end of spring runoff) and other historic data (Appendix C) did not show any exceedences of water quality standards and the periphyton data did not indicate an impairment condition. In addition, sample results from runoff conditions on June 6, 2002 do not show any exceedences of water quality standards. This sampling included locations near the mouth (below Sandbar Creek) and just above Sandbar Creek in the upstream portion of Willow Creek which apparently was not included as part of the impaired stream segment for the 1996 303(d) list.

Two stream sediment samples were collected during June of 2001. Sediment analytical results are shown in Table 2-7. Analytical results show that concentrations of certain metals, including copper, iron, manganese, and arsenic, are greater than published guidance levels denoting potentially harmful conditions for aquatic biota (Jones et al., 1997; Long and Morgan, 1990). This information indicates that metals concentrations in stream sediments could impact aquatic life support. Periphyton data does not imply an impairment condition (Bahls, 2001), although macroinvertebrate data from Willow Creek above Sandbar Creek implies that the water body is impaired based on a borderline partial support conclusion (Bollman, 2002). This partial support condition could be influenced more by sediment, habitat, and channel conditions than by metals contamination based on the individual macroinvertebrate metrics and other visual indicators of negative impacts associated with habitat and stream channel conditions as observed by MDEQ water quality specialists.

Table 2-7 Stream Sediment Metals Concentrations from Willow Creek Sampling Site.

	Site WCSW-1 (upstream of Sandbar Creek) Concentration mg/Kg	Site WCSW-2 (near the mouth of Willow Creek) Concentration mg/Kg
Aluminum	17300	32400
Arsenic	116	30
Cadmium	2	1
Copper	101	80
Iron	59400	30600
Lead	53	33
Manganese	2050	2530
Nickel	18	16
Zinc	158	163

Metals concentrations are total (EPA Method 3050)

The sediment chemistry data from both Willow Creek locations do indicate the potential for upstream sources of metal contamination, which is not surprising for the segment of Willow Creek below Sandbar Creek. At least one historic mine prospect is located near the headwaters of Willow Creek which could account for the elevated sediment metals concentrations upstream (and possibly downstream to some extent) of the confluence of Sandbar Creek. Other potential upstream sources include erosion and/or leaching of metals from apparently mineralized bedrock and soils in highway roadcuts, or recharge from naturally mineralized groundwater. Also, the upstream Willow Creek sediment sample was taken immediately downstream of a wooden bridge. Wood treatment residue could be a source of arsenic, which is one of the metals occurring at elevated sediment concentrations at the upstream sampling site.

The above data is not sufficient to conclude that Willow Creek is impaired due to metals, but it does indicate a need for more data to evaluate whether or not Willow Creek is impaired. From a practical restoration perspective, this additional data is more important for the section of Willow Creek above Sandbar Creek since restoration efforts in Sandbar Creek, as developed above in Sections 2.1 through 2.4, should address any impairment conditions in the lower portion of Willow Creek if it can be established that there are not any significant metals loading problems in the upper portions of Willow Creek.

2.5.2 Sampling and Restoration Planning for Willow Creek

To ensure that there are not any significant upstream impairment conditions in Willow Creek, at least one location above WCSW-1 should be sampled. The sample location(s) will need to be selected based on an inventory of potential metals sources, with a likely location being about halfway between the Flesher Pass road crossing and the current WCSW-1 sample location site. This location would likely capture upstream metals loading impacts, should they occur. If the sample meets the target criteria in Table 2.8, then it can be assumed that the portion of Willow Creek above Sandbar Creek is not impaired from metals. It can also then be concluded that any potential impairment conditions in the section of Willow Creek below Sandbar Creek are being addressed via TMDL development for Sandbar Creek.

If the target criteria in Table 2.8 cannot be met, then this upper segment of Willow Creek will be considered impaired due to metals and the Table 2.8 targets will apply as TMDL development targets in the same manner that they are applied to Sandbar Creek (Section 2.4). TMDLs for the metals of concern will apply using the equation(s) in Appendix A, and the allowable load will be allocated to the sum of impacts from historical mining, road disturbances, and natural background loading, with further refinement to be pursued as the next step toward restoration planning. Under this scenario, it can be concluded that any potential impairment conditions in the section of Willow Creek below Sandbar Creek are being addressed via TMDL development for both Sandbar Creek and upper Willow Creek.

Table 2-8 Willow Creek Impairment Determinations and Target Criteria for Metals.

POLLUTANT/SAMPLE MEDIA	TARGET(S)
Metals/Water Quality	Continued compliance with water quality standards (reference Appendix A and WQB-7) during low and high flow conditions. Also reference Table 2-4 for applicable targets should impairment conditions exist.
Metals/Biota	Macroinvertebrate and periphyton communities must show no impairment from metals.

SECTION 3.0

POORMAN CREEK DRAINAGE

Poorman Creek originated near the continental divide and empties into the Blackfoot River just south of the Town of Lincoln (Figure 1-2). Significant historic mining has occurred in the drainage resulting in the creek being listed as impaired for metals for its entire length of 14 miles (Table 1-2).

3.1 Available Water Quality Data

Available water quality data from Poorman Creek drainage are summarized in Table 3-1. Current data includes surface water quality data from three sites sampled by the former Montana Department of State Lands in 1993 (MDSL, 1995), water quality data from six sites sampled in June 1996 by MDEQ, surface water and sediment chemistry data from three sites sampled in June 2001 by MDEQ, surface water quality data from five sites sampled in June 2002 by Hydrometrics, and surface water quality from six sites and sediment chemistry data from three sites sampled in October 2002 by Hydrometrics. Of the 23 water samples identified, 15 were collected from the mainstem of Poorman Creek, three were collected from the South Fork of Poorman Creek near the confluence with the mainstem, and five were collected from Swansea Gulch, a tributary to Poorman Creek where significant historic mining activities have occurred. The majority of available data was collected under high flow conditions (June), although samples taken during June 2001 were at relatively lower flows at the latter part of the falling limb of the hydrograph. The October 2002 sampling results represent the only low flow data at baseflow conditions from most portions of the drainage (Table 3-1). Results from three water samples collected by MDFWP in the early 1970s were not used in this evaluation due to the dated nature of this information. Water quality and sediment chemistry data from Poorman Creek is included in Appendix C and in relevant sections of this report. Sampling locations are shown on Figure 3-1.

3.2 Poorman Creek Drainage Impairment Conditions

3.2.1 Water Column Chemistry

Table 3-2 provides a summary of water quality exceedences in Poorman Creek drainage, relative to applicable water quality standards for higher flow and low flow (baseflow) conditions. Water quality data collected in June 1996, 2001 and 2002 were used to represent high flow conditions, while data collected in September 1993 and October 2002 represent low flow conditions.

Based on the current water quality data, exceedences of numeric water quality criteria for metals in Poorman Creek drainage are restricted to an unnamed tributary in the upper drainage previously referred to as Swansea Gulch (Figure 3-1). Results from a June 1996 water sample collected near the mouth of Swansea Gulch (the only high flow water quality data available from the drainage), exceeded the chronic aquatic life criteria for cadmium, copper and lead (Table 3-2). The acute aquatic life criteria for copper was also exceeded in this sample, while no human health or domestic use standards were exceeded. Two water samples collected from Swansea

Gulch near the Swansea tailings in September 1993 as part of Montana's abandoned mine prioritization process (MDSL, 1995), exceeded the acute aquatic criteria for copper and lead. Metals concentrations in an October 2002 water sample collected near the mouth of Swansea Gulch were all below applicable water quality criteria (Appendix C).

Table 3-1 Summary of Current Available Water Quality Data from Poorman Creek Drainage.

Stream Segment	Site Designations	Date Sampled	Sampled By	Analyses
Poorman Ck Upstream of South Fork	011	6/96	MDEQ	Metals, SO4, hard., flow, pH/SC
	C03POORC01	6/01	MDEQ	Metals, SO4, hard., flow, pH/SC
	PCSW-4	6/02	Hydrometrics	Metals, SO4, hard., flow, pH/SC
	PCSW-7	10/02	Hydrometrics	Metals, SO4, hard., flow, pH/SC
Poorman Ck between S. Fork and FS Boundary	4127PO01	6/96	MDEQ	Metals, SO4, hard., flow, pH/SC
	4127PO02	6/96	MDEQ	Metals, SO4, hard., flow, pH/SC
	C0POORC02	6/01	MDEQ	Metals, SO4, hard., flow, pH/SC
	PCSW-3	6/02; 10/02	Hydrometrics	Metals, SO4, hard., flow, pH/SC
Poorman Ck Downstream of FS Boundary	4126PO01	6/96	MDEQ	Metals, SO4, hard., flow, pH/SC
	C03POORC03	6/01	MDEQ	Metals, SO4, hard., flow, pH/SC
	PCSW-1	6/02; 10/02	Hydrometrics	Metals, SO4, hard., flow, pH/SC
	PCSW-2	6/02; 10/02	Hydrometrics	Metals, SO4, hard., flow, pH/SC
South Fork of Poorman Ck	4128PO02	6/96	MDEQ	Metals, SO4, hard., flow, pH/SC
	PCSW-5	6/02; 10/02	Hydrometrics	Metals, SO4, hard., flow, pH/SC
Swansea Gulch (tributary to Poorman Ck)	4128PO01	6/96	MDEQ	Metals, SO4, hard., flow, pH/SC
	PCSW-6	10/02	Hydrometrics	Metals, SO4, hard., flow, pH/SC
	25-208-SW-1	9/93	MDSL	Metals, pH
	25-208-SW-2	9/93	MDSL	Metals, pH
	25-208-SW-3	9/93	MDSL	Metals, pH

SO4- Sulfate
hard.- hardness as CaCO₃
SC- Specific Conductance

For the 19 remaining water samples collected from Poorman Creek drainage outside of Swansea Gulch, no exceedences of numeric water quality criteria were recorded, although low levels of copper have been detected. In addition, no metal precipitate sludges or metal colloid concentrations creating problem turbidity levels or visible stream deposits are known to exist in Poorman Creek drainage.

3.2.2 Metals in Streambed Sediments

Results from six stream sediment samples analyzed for total metals concentrations were reviewed to determine if stream sediments might contribute to metals-related impairment in Poorman Creek. Three of the sediment samples were collected by MDEQ in June 2001 with sampling sites corresponding to water sampling locations C03POORC01, C03POORC02 and C03POORC03 (Figure 3-1). The 2002 samples (sample sites PCSed02-1, -2, -3 on Figure 3-1) were collected to verify elevated metals concentrations at one 2001 sample site (C03POORC02), and to evaluate possible sources for metals in sediments.

Table 3-2 Poorman Creek Drainage Metals Impairment Summary.

Metal	Season	n	Concentration Range µg/L	Exceedence Summary
Aluminum	High Flow	5	<10 to 40	<ul style="list-style-type: none"> Consistently less than 87 µg/L chronic aquatic life criteria
	Low Flow	8	<50	<ul style="list-style-type: none"> Consistently less than 87 µg/L chronic aquatic life criteria
Cadmium*	High Flow	13	<0 to 0.5	<ul style="list-style-type: none"> Exceeds hardness-based chronic and acute aquatic life criteria in only high flow sample from Swansea Gulch.
	Low Flow	8	<0.1 to 0.1	<ul style="list-style-type: none"> Consistently less than hardness-based chronic and acute aquatic life criteria and 5 µg/L human health standard
Copper*	High Flow	13	1 to <10	<ul style="list-style-type: none"> One exceedence of hardness-based chronic and acute aquatic life criteria (in Swansea Gulch).
	Low Flow	8	<1 to 21.3	<ul style="list-style-type: none"> Exceeds hardness-based chronic aquatic and acute aquatic life criteria in 2 of 3 samples from Swansea Gulch. Consistently less than 1,300 µg/L human health standard.
Iron	High Flow	13	10 to 200	<ul style="list-style-type: none"> Consistently less than 300 µg/L guidance level and 1,000 µg/L chronic aquatic life criteria.
	Low Flow	8	<30 to 265	<ul style="list-style-type: none"> Consistently less than 300 µg/L guidance level and 1,000 µg/L chronic aquatic life criteria
Lead*	High Flow	13	1 to 8	<ul style="list-style-type: none"> Exceeds hardness dependent chronic aquatic life criteria in single high flow sample from Swansea Gulch.
	Low Flow	8	<2 to 4.3	<ul style="list-style-type: none"> Exceeds hardness dependent chronic and acute aquatic life criteria in two of three samples from Swansea Gulch.
Manganese	High Flow	8	<5 to 19	<ul style="list-style-type: none"> Consistently less than 50 µg/L guidance level
	Low Flow	8	4.1 to 17.5	<ul style="list-style-type: none"> Consistently less than 50 µg/L guidance level
Zinc*	High Flow	13	0.2 to 20	<ul style="list-style-type: none"> Consistently less than 2,100 µg/L human health standard and hardness-based chronic and acute aquatic life criteria
	Low Flow	8	7.6 to <10	<ul style="list-style-type: none"> Consistently less than 2,100 µg/L human health standard and hardness-based chronic and acute aquatic life criteria

High flow measurements include results from all June samples listed in Table 3-1.

Evaluation of exceedences based on total recoverable fraction except for aluminum, which is based on dissolved fraction.

*-aquatic criteria based on actual hardness of water sample.

Sediment sample analytical results are shown in Table 3-3. Of the six samples, the two samples collected from the mainstem of Poorman Creek between the South Fork and Little Davis Gulch (site C03POORC02/PCSed02-1, Figure 3-1) contained the highest concentrations of most metals. Concentrations of copper and lead are significantly greater than published guidance values denoting potentially harmful conditions for aquatic biota (Jones et al., 1997; Long and Morgan, 1990). The concentration of copper in the 1996 sample from downstream site C03POORC03 (Figure 3-1) was similar to those at C03POORC02/PCSed02-1. Stream sediment metals concentrations generally decreased in an upstream direction with sample PCSed02-3, from Poorman Creek channel upstream of Swansea Gulch, having the lowest concentrations of most metals (Table 3-3). All concentrations at this site tend to be below or only slightly above the generalized stream sediment toxicity guidance values discussed above.

Table 3-3 Stream Sediment Metals Concentrations from Poorman Creek Main Channel.

Site	C03POORC 01	C03POORC 02	C03POORC 03	PCSed02-1	PCSed02-2	PCSed02-3
Location (and corresponding site designations)	Upper Poorman Ck (PCSW-4)	Mainstem downstream of S. Fork (PCSW-3)	Mainstem downstream of FS Boundary (PCSW-2)	Mainstem Downstream of S. Fork (PCSW-3)	Mainstem downstream of Swansea Gulch (PCSW-7)	Mainstem Upstream of Swansea Gulch
Sample Date	6/01	6/01	6/01	10/02	10/02	10/02
Aluminum	21100	15800	21500	na	na	na
Arsenic	12	28	24	26	7	7
Cadmium	<1	3	<1	3	<2	<2
Copper	27	224	140	172	84	43
Iron	17300	11900	17500	na	na	na
Lead	54	353	68	313	185	46
Manganese	595	365	451	na	na	na
Nickel	37	13	22	17	13	25
Zinc	89	137	91	155	84	95

na-not analyzed

Sediment samples comprised <63 µm size fraction

Metals concentrations are total (EPA Method 3050) and are in mg/Kg

Site locations shown on Figure 3-1

3.2.3 Impairment determinations for Poorman Creek

The above discussions on water quality and sediment chemistry, along with the biological data referenced in Section 1.3.1, sufficiently justify the metals impairment determination for the listed portion of Poorman Creek and the need for TMDL development for multiple metals. Although available water quality data from the mainstem of Poorman Creek do not reveal any exceedences of the numeric water quality criteria, the elevated metals concentrations in sediments (in particular copper and lead), the periphyton data (percent abnormal diatom cells), the significant number of potential mining related sources, and the elevated metals concentrations in Swansea Gulch all indicate that beneficial uses in Poorman Creek likely are impaired due to metals and justify a continued metals impairment determination and TMDL development for the mainstem of Poorman Creek.

3.3 Source Characterization

3.3.1 Metals Source Inventory

There are several historic hardrock mines located within the Poorman Creek drainage, which are potential sources of metals loading to the creek. The MDEQ Abandoned Mine and U.S. Bureau of Mines databases identify more than 30 historic mines in the drainage and numerous small prospects and diggings (Figure 3-1). Most of these mines are limited in size and typically consist of minor prospects with mine workings of limited extent and small associated waste rock piles. Based on available water quality data, the majority of these sites do not appear to significantly impact water quality. However, some of these mines are significant in size and, based on available information, do impact surface water quality in Poorman Creek drainage. Other potential metals loading sources in the drainage may include roads, placer mine tailings in the lower drainage, and natural background sources.

Appendix E includes a metals loading analysis performed on Poorman Creek drainage to better delineate specific sources of metals loading. The loading analysis results (Table 3-4) indicate that multiple metals loading sources exist throughout the drainage during high flow conditions, with the greatest load increases occurring in the downstream half of the drainage. Despite the greater metal loads in the downstream reaches, available water quality data show that metals concentrations are greatest in Swansea Gulch due to the relatively low streamflow rate (resulting in a lower dilution capacity). Water quality data also indicate that Swansea Gulch is the only known stream segment in the drainage that exceeds numeric water quality standards for metals and thus is impaired due to metals concentrations in the water column. As previously discussed however, elevated concentrations of certain metals in Poorman Creek sediments, along with the available biological data, indicate that portions of Poorman Creek main stem are impaired from metals as well.

Table 3-4 Metals and Sulfate Loading Trends in Poorman Creek Drainage for June 13, 1996.

SITE	Description	Flow (cfs)	Copper (lb/day)	Iron (lb/day)	Sulfate (lb/day)
4128PO014	Swansea Gulch above Stemple Rd	0.79	0.043	0.21	26.8
011	Poorman Ck upstream of S. Fork	8.92	0.096	1.92	365
4128PO02	S. Fork Poorman Ck near mouth	17.66	0.095	3.81	571
4127PO01	Poorman Ck below McClellan Ck	56.97	0.614	6.14	2,240
4127PO02	Poorman Ck at NF boundary	59.05	0.318	22.3	2,290

Site listed in downstream order, locations shown on Figure 3-1.

Swansea Gulch contains a number of relatively large historic mines including the Swansea Mine/Tailings Complex and Silver Belle Mine (Figure 3-1). This group of mines and support facilities represents the only currently confirmed sources of metals-related water quality impairment in Poorman Creek drainage (reference Appendix E for additional Swansea Gulch source loading analysis results). It is possible that most or all significant impairment conditions in the main stem are the result of metals loading sources within Swansea Gulch. This scenario is supported by the relatively low concentrations of metals in sediment at PCSW-4 upstream of Swansea Gulch. On the other hand, the somewhat elevated percentage of abnormal diatom cells

at this same location tends to contradict this scenario. Nevertheless, the first phase of TMDL development, load allocation, and restoration planning in Poorman Creek drainage focuses on Swansea Gulch, with allocations and restoration plans to be developed in subsequent phases as necessary once additional information on main stem and tributary conditions throughout the drainage becomes available. Section 6.3 includes a monitoring strategy for obtaining information necessary for subsequent phases of TMDL development.

3.4 Restoration Targets, TMDLs and Load Allocations

3.4.1 Metals Restoration Targets for Poorman Creek and Swansea Gulch

The summary of impairment conditions (Table 3-2) identified cadmium, copper and lead as metals that exceed applicable B-1 water quality criteria in Swansea Gulch. Table 3-5 provides high flow and low flow water quality restoration targets, or maximum allowable concentrations, for these metals based on the numeric chronic aquatic life criteria listed in WQB-7 (MDEQ, 2001b). Basing restoration targets on the chronic aquatic criteria will ensure that other numeric criteria (human health, acute aquatic life) are met since the chronic criteria are the most stringent (lowest concentration). Compliance for the water quality targets will be based on high and low flow water quality data, with no more than one measurement for a particular metal exceeding the chronic criteria by more than 10%. This approach is consistent with MDEQ guidance for making beneficial use support determinations (MDEQ, 2002).

The restoration targets have been adjusted for water hardness based on hardness values measured in Swansea Gulch under high flow (50 mg/L) and low flow (75 mg/L) conditions. Due to the hardness dependence of the numeric criteria, the actual targets for these three metals will vary based on the water hardness at any given time. Appendix A provides additional information regarding calculation of numeric water quality criteria-based restoration targets and determination of compliance with the restoration targets.

In addition to the water quality restoration targets, another target for both Poorman Creek and Swansea Gulch is that metals concentrations in sediments cannot impede beneficial uses, with focus on aquatic life support. This target applies to all metals, either individually or in combination, which may occur at potentially toxic concentrations in stream sediments. Lead and copper are of special concern given the relatively high levels in sediment chemistry as identified in Table 3-3. Assessment of stream sediment concentrations and beneficial use support conditions will be consistent with the stream sediment screening approach discussed in Section 1.2.3.

As an additional measure of water quality restoration, a target for macroinvertebrate and periphyton communities also applies to Swansea Gulch and Poorman Creek. Metals concentration must not impede attainment of full support conditions when compared to a known reference condition using standard MDEQ protocols (reference Appendix A).

All Swansea Gulch targets apply at Site PCSW-6 (reference Figure 3-1). Poorman Creek targets apply upstream of Swansea Gulch (at or near PCSW-4), upstream of S. Fk Poorman Creek and downstream of Swansea Gulch (at or near PCSW-7), near the mouth of the S. Fk. Poorman

Creek (at or near PCSW-5), and at least one location downstream of the confluence of the S. Fk. Poorman Creek (such as PSCW-3 and/or 4127PO01). Additional target locations may apply further upstream on the S. Fk. Poorman Creek, near the mouth of McClellan Gulch, or other tributary or mainstem locations where subsequent water quality monitoring indicates impairment conditions. The addition of new target locations and/or subsequent water quality analyses efforts can be used to justify modifications to these target compliance locations.

It is important to note that the above targets represent minimum requirements for protecting beneficial uses identified within Montana's Surface Water Quality Standards, and are based on interpretations of available data presented within this plan. Other regulatory programs with water quality protection responsibilities may impose additional requirements to ensure full compliance with all appropriate local, State and Federal laws.

3.4.2 Poorman Creek Drainage Metals TMDL

Since available water quality data show that numeric water quality criteria are exceeded in Swansea Gulch but not in other portions of Poorman Creek drainage, the initial phase of TMDL development includes TMDL calculations for Swansea Gulch only. TMDLs will be further developed for the main stem of Poorman Creek as necessary following a more detailed source assessment associated with the elevated sediment metals concentrations and metals-impaired biological communities as detailed in the Phase I report (Confluence et al., 2002) and by Bahls (2001). As discussed in Section 3.3.1, it is possible that most or all significant impairment conditions in the main stem are the result of metals loading sources within Swansea Gulch. If so, implementation of the Swansea Gulch TMDL would address metals-related impairment in the main stem as well.

Similar to the TMDL development approach utilized for Sandbar Creek drainage (Section 2.4.2), metals TMDLs for Swansea Gulch are designed to address the full range of streamflow rates and potential restoration targets applicable to Swansea Gulch. Metals TMDLs for Swansea Gulch (as well as any other point in Poorman Creek drainage) are defined by Equation 3-1. Equation 3-1 allows calculation of metals TMDLs for any streamflow conditions and any water quality restoration targets which may occur throughout Poorman Creek drainage.

Equation 3-1: *Total Maximum Daily Load (lb/day) = (X ug/l)(Y cfs)(0.0054)*

where:

X = the applicable water quality numeric standard (target) in ug/l with hardness adjustments where applicable;

Y = streamflow in cubic feet per second;

(0.0054) = conversion factor

Table 3-6 provides high flow and low flow TMDLs for copper, cadmium and lead. The TMDLs were calculated from Equation 3-1, using the single high flow (0.79 cfs) and low flow (0.16 cfs) measurements recorded near the mouth of Swansea Gulch (site PCSW-6). Restoration targets were taken from Table 3-5. The calculated TMDLs represent the maximum load (lbs/day) of each particular metal that the creek can accommodate without exceeding applicable water quality standards based on the specified streamflow conditions and restoration targets.

Table 3-5 Metals Water Quality Restoration Targets for Swansea Gulch and Poorman Creek Drainage.

Stream	Pollutant	Target(s)	Limiting Beneficial Use
Swansea Gulch	Copper ¹	5.2 ug/l (high flow) 7.3 ug/l (low flow)	Aquatic Life (chronic) Aquatic Life (chronic)
Swansea Gulch	Cadmium ¹	0.16 ug/l (high flow) 0.2 ug/l (low flow)	Aquatic Life (chronic) Aquatic Life (chronic)
Swansea Gulch	Lead ¹	1.3 ug/l (high flow) 2.2 ug/l (low flow)	Aquatic Life (chronic) Aquatic Life (chronic)
Swansea Gulch and Poorman Creek	Metals	Continued compliance with WQB-7 numeric water quality standards No metals concentrations in sediments that may impede beneficial uses Macroinvertebrate and periphyton communities must show no impairment from metals.	Aquatic Life Aquatic Life Aquatic Life

Notes: 1. Targets are estimated based on predicted hardness values of 50 mg/L during high flow and 75 mg/L at low flow after completion of restoration activities; actual targets will be determined by hardness at time of sampling as defined in Appendix A

Table 3-6 Poorman Creek TMDL and Load Reduction Requirements for Metals at Specified High Flow and Low Flow Conditions - Site PCSW-6 in Swansea Gulch.

Pollutant	Target (ug/l)	Calculated Low Flow and High Flow TMDL (lb/day)	% Total Load Reduction Needed to Meet TMDLs and Targets
Copper	7.3 (low flow) 5.2 (high flow)	0.006 0.02	0% (low flow); 53% (high flow)
Cadmium	0.2 (low flow) 0.16 (high flow)	0.0002 0.0007	0% (low flow); 65% (high flow)
Lead	2.2 (low flow) 1.3 (high flow)	0.002 0.0055	0% (low flow); 84% (high flow)

Mean low flow of 0.16 cfs based on single low flow measurement obtained near mouth of Swansea Gulch (site PCSW-6) on 10/7/02

Mean high flow of 0.79 cfs based on single high flow measurement obtained near mouth of Swansea Gulch (site 4128PO01) on 6/13/96

Sample locations shown on Figure 3-1.

No load reductions required under the example low flow conditions since no exceedences occurred in the 10/7/02 sample.

Some additional notes concerning the TMDLs in Table 3-6 and the target conditions they are intended to satisfy include:

- Meeting the copper, lead, and cadmium TMDLs is expected to satisfy the target associated with sediment toxicity for two reasons. First, restoration activities designed to address existing sources of these metals (primarily historic mining-related) should also eliminate the source(s) of elevated metals concentrations in sediments. Secondly, as metals loads in Swansea Gulch are reduced to TMDL levels, fine-grained metals-bearing sediments likely will flush through the system during high flow periods via typical sediment transport processes. As source areas are reclaimed, the displaced sediments (in Swansea Gulch and Poorman Creek downstream of Swansea Gulch) will be replaced with fewer and cleaner sediments. Because other metals, which may occur at elevated concentrations in sediments likely are derived from the same mining-related sources as copper, lead, and cadmium, meeting these TMDLs is expected to address possible sediment toxicity issues related to other metals in Swansea Gulch. This is expected to also result in significant reductions in sediment metals concentrations in Poorman Creek. The response of sediment chemistry to implementation of the metals TMDLs will be documented through post-implementation sediment testing (Section 6.3).
- Meeting all of the metals TMDLs is expected to eliminate any metals-related impediments to satisfying the target associated with macroinvertebrate and periphyton communities being at full support conditions in comparison to a reference stream condition.

Table 3-6 also includes the percent metals load reductions required to meet the calculated TMDLs. The required load reductions are based on the example TMDLs and the actual metals loads calculated from the corresponding June 1996 and October 2002 streamflow and water quality data. Based on the June 1996 conditions, required load reductions for copper, cadmium and lead equate to 53%, 65% and 84%, respectively. Based on low flow conditions documented during October 2002, no associated load reductions are required during low flow since metals

concentrations were all below applicable water quality standards. Load reductions required to meet the metals TMDLs in the future will be dependent on actual in-stream metals loads and the corresponding TMDLs calculated from Equation 3-1.

The calculated metals TMDLs and required load reductions apply to the specific streamflow conditions and restoration targets used for their calculation only. Due to the limited streamflow data available, the degree to these conditions represent typical high flow and low flow conditions in the drainage is unknown. It is likely that TMDLs calculated in the future for specific streamflow conditions may vary significantly from these examples. Ultimately, the TMDL is equivalent to the load of a particular pollutant that Swansea Gulch (and Poorman Creek) can support without exceeding B-1 water quality standards as determined from Equation 3-1. Appendix A includes information on the calculation of TMDLs. Available water quality data used in calculations of TMDLs and load reduction requirements are in Appendix C.

3.4.3 Load Allocations

As discussed in Appendix A, the metals TMDLs can be expressed as the sum of the load allocations plus the sum of the waste load allocations plus a margin of safety. Because there are no point source discharges subject to the Montana Pollutant Discharge Elimination System permit program in Poorman Creek drainage, waste load allocations are not required. The margin of safety is addressed implicitly through the use of chronic aquatic standards for calculation of TMDLs under all conditions, incorporation of biologic and sediment criteria for water quality restoration targets, calculation of TMDLs for various flow conditions and water hardness conditions, and adoption of an environmental monitoring program designed to further quantify metals loading sources, assist in restoration planning, and assess TMDL compliance (Section 6.3). In addition, the numeric water quality criteria used in establishing restoration targets contain built-in margins of safety for protection of beneficial uses. Since there are no waste load allocations or explicit margins of safety required, the metals TMDLs for Swansea Gulch are the sum of the nonpoint source load allocations in the drainage.

Based on current knowledge of metals loading sources in Swansea Gulch drainage, nonpoint sources of metals impairment potentially in need of load allocations are divided into two categories:

- Category 1: Potential sources currently identified in the Swansea drainage including the Swansea Mine/Mill Complex and the Silver Belle mine (Figure 3-1); plus potential natural background loading within Swansea Gulch.
- Category 2: Other potential nonpoint sources in Swansea Gulch not yet identified, including possible mining-related disturbances, roads, or other human-caused disturbances.

Table 3-7 includes preliminary load allocations for these nonpoint source categories for Swansea Gulch. At this time, the entire Swansea Gulch load allocations for copper, cadmium and lead (which are equivalent to the corresponding TMDLs) are allocated to the Category 1 sources. This assumes that no additional metals loading sources (either human-caused or natural) are

present in the drainage, and that the Swansea Gulch restoration targets can be met by addressing Category 1 sources only.

3.4.4 Future TMDL Development and Load Allocations

Section 6.3 describes a water monitoring program designed to further evaluate impairment conditions and potential metals loading sources within Poorman Creek drainage. If future monitoring identifies additional sources within Swansea Gulch, then these sources would likely fall under Category 2 as defined above and load allocations in Table 3-7 will need to be adjusted accordingly. Identification of additional sources may require that load allocations for currently identified sources (Category 1 sources), be decreased to ensure that water quality standards can be achieved. If the monitoring program identifies sources of metals-related impairment in other portions of Poorman Creek drainage, TMDLs and load allocations will be developed for the affected stream segments to ensure all portions of Poorman Creek drainage ultimately comply with water quality standards.

Attainment of TMDL goals through restoration of mining-related disturbances and other human-caused sources assumes that metals loading impacts can be confirmed for these sources and that restoration goals can be achieved via reasonable land, soil and water conservation practices. Ultimately, the load allocation will be driven by attainment of the B-1 classification-based water quality targets listed in Table 3-5.

Table 3-7 Preliminary Metals Load Allocations for Swansea Gulch Drainage.

METAL	TMDL lb/Day	Identified Sources ¹ (Category 1)	Possible Other Sources ² (Category 2)	Margin of Safety
Copper	High Flow-0.02 Low Flow- 0.006	0.02 0.006	No allocation at this time	Implicit MOS applied through conservatism in TMDL calculation process and required post- implementation monitoring to assess performance of restoration actions.
Cadmium	High Flow-0.0007 Low Flow-0.0002	0.0007 0.0002	No allocation at this time	
Lead	High Flow-0.0055 Low Flow-0.002	0.0055 0.002	No allocation at this time	

1- Includes mining disturbances as described in Section 3.3 and shown on Figure 3-1 and natural background loading.

2- Includes additional human-caused nonpoint sources within Swansea Gulch, which may be identified through future monitoring. If a load allocation is required for additional sources in the future, then the load allocation for Identified Non-Point Sources must be reduced accordingly.

SECTION 4.0

RESTORATION PLAN FOR BEARTRAP/MIKE HORSE CREEKS

Beartrap Creek flows westward from the continental divide and joins Anaconda Creek to form the Blackfoot River. The lower portion of the creek (approximately 4,500 feet) is heavily impacted by historic mining activities and is included in the current UBMC mine reclamation program (Appendix B). As discussed in Section 1, temporary water quality standards have been adopted for certain waters within the UBMC including the listed segment of Beartrap Creek (Appendix B). Beartrap Creek is also listed as impaired due to metals from the confluence with Anaconda Creek upstream to Mike Horse Creek.

Mike Horse Creek joins Beartrap Creek immediately downstream of the Mike Horse Tailings Impoundment (Figure 4-1). Mike Horse Creek drainage is the site of the most extensive historic mining at the UBMC, resulting in significant impacts to the lower 3,000 feet of Mike Horse Creek. Although not listed as impaired on the most recent 2002 303(d) list, metals TMDLs have been developed for Mike Horse Creek due to its significance as a source of metals loading to the listed portion of Beartrap Creek, and due to the overwhelming evidence documenting its impaired condition. As with Beartrap Creek, temporary water quality standards have been adopted for the impacted section of Mike Horse Creek.

4.1 Available Water Quality Data

Significant water quantity data has been generated for Beartrap Creek and Mike Horse Creek by Asarco in conjunction with the UBMC mine reclamation program. Current water quality data from the listed portion of Beartrap Creek drainage includes sampling results from three established monitoring sites: BRSW-23 in the upper portion of the listed stream segment, BRSW-39 in the middle portion, and BRSW-38 in the lower portion (Figure 4-1). Established monitoring sites in the metals-impaired section of Mike Horse Creek include: BRSW-4 in the upper portion of Mike Horse Creek; BRSW-22 located downstream of Mike Horse Creek Road; and BRSW-35 located at the mouth of Mike Horse Creek (Figure 4-1). Samples have been collected at all of these sites under a variety of streamflow conditions, including high flow, low flow, and early spring runoff. Although water quality data from these sites dates back to at least the early 1990s, only the 1996 and later data is considered representative of current conditions. Metals concentrations in the metals-impaired portions of Beartrap and Mike Horse Creeks have decreased considerable since the early 1990s due to completion of mine reclamation activities in these drainages. Therefore, only the 1996 and later data have been used for evaluating impairment conditions and developing metals TMDLs. Also, results from sporadic water sampling at a limited number of additional sites in Beartrap and Mike Horse Creeks were not utilized in this restoration plan since water quality data from the sites listed above are adequate for TMDL development. A summary of the current water quality data utilized for TMDL development is shown in Table 4-1. The full water quality dataset is included in Appendix C.

Table 4-1 Summary of Current Water Quality Data from Beartrap and Mike Horse Creek Drainages.

Stream Segment*	Site Designations	Number of Samples**	Sampled By	Analyses
Upper Beartrap	BRSW-23	17	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC
Middle Beartrap	BRSW-39	7	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC
Lower Beartrap	BRSW-38	11	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC
Upper Mike Horse	BRSW-4	14	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC
Middle Mike Horse	BRSW-22	16	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC
Lower Mike Horse	BRSW-35	9	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC

*Descriptions refer to the metals-impacted portions of Beartrap Creek and Mike Horse Creek (Figure 4-1).

**Samples collected from 1996-2001. Earlier data from these sites, as well as sporadic data from a limited number of other sites, is not included.

SO₄ – sulfate; hard. – hardness as CaCO₃; SC – specific conductance

4.2 Beartrap Creek and Mike Horse Creek Impairment Conditions

Tables 4-2 and 4-3 provide a comparison of current water quality data (1996 through 2001) from the metals-impacted segments of Beartrap and Mike Horse Creeks to applicable water quality standards for various flow conditions. The water quality data are compared to the State of Montana human health, chronic aquatic life, and acute aquatic life numeric criteria for B-1 classification waters. Although temporary water quality standards were adopted and are currently in effect in both of these stream segments, B-1 classification standards are utilized for evaluating impairment conditions since these standards are scheduled to go back into effect once the temporary standards expire.

Water quality data (metals concentrations) are compared to the applicable water quality standards for three distinct streamflow conditions: high flow, low flow and early spring runoff. Water quality data collected in May and June (spring runoff period) are used to represent high flow conditions, while data collected between September and March represent low flow conditions. The early spring runoff period corresponds to the initial stages of spring runoff and onset of the rising limb of the streamflow hydrograph. This period is characterized by water quality data collected in April. The April data generally exhibits the greatest concentrations and loads for most metals as discussed under Section 4.3.

The summary of impairment conditions for Beartrap Creek is based on water quality data collected at two established monitoring locations; BRSW-23 and BRSW-38 (Figure 4-1). Seasonal water quality data has been collected for a number of years from each of these sites as part of the UBMC mine reclamation program, providing an extensive database for comparison to water quality standards. These sites also provide good spatial coverage of the listed stream segment. The Mike Horse Creek impairment summary is based on water quality data from sites BRSW-4 and BRSW-22 (Figure 4-1). As shown in Tables 4-2 and 4-3, available data for the period 1996-2001 show that water quality conditions within Mike Horse and Beartrap Creeks routinely exceed applicable B-1 classification standards for cadmium, copper, iron, lead, manganese, and zinc.

Table 4-2 Beartrap Creek Drainage Seasonal Metals Impairment Summary for Monitoring Sites BRSW-23 and BRSW-38.

Metal	Season	N	Concentration Range µg/L	EXCEEDENCE SUMMARY	Water Quality Standards References
Aluminum	High Flow	11	<50 to <50	<ul style="list-style-type: none"> Consistently less than 87 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i)-WQB-7 17.30.637(1)(d)
	Low Flow	12	<50 to <50	<ul style="list-style-type: none"> Consistently less than 87 µg/L chronic aquatic life criteria 	
	Early Runoff	4	<50 to 98	<ul style="list-style-type: none"> 1 exceedence of 87 µg/L chronic aquatic life criteria 	
Cadmium*	High Flow	10	4 to 10	<ul style="list-style-type: none"> Consistently exceeds 0.3 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	11	2 to 37	<ul style="list-style-type: none"> Consistently exceeds 0.4 µg/L chronic aquatic life criteria 	
	Early Runoff	5	45 to 67	<ul style="list-style-type: none"> Consistently exceeds 0.6 µg/L chronic aquatic life criteria 	
Copper*	High Flow	10	43 to 79	<ul style="list-style-type: none"> Consistently exceeds 9.3 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	12	4 to 42	<ul style="list-style-type: none"> Occasionally exceeds 13.2 µg/L chronic aquatic life criteria 	
	Early Runoff	5	180 to 778	<ul style="list-style-type: none"> Consistently exceeds 23.9 µg/L chronic aquatic life criteria 	
Iron	High Flow	10	<50 to 270	<ul style="list-style-type: none"> Consistently less than 300 µg/L domestic use 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d) 17.30.637(1)(a) 17.30.601
	Low Flow	10	45 to 8434	<ul style="list-style-type: none"> 2 exceedence of both the 300 µg/L domestic use and 1000 ug/l chronic aquatic life criteria 	
	Early Runoff	5	120 to 9500	<ul style="list-style-type: none"> 3 exceedences of 300 µg/L domestic use 2 exceedences of 1000 µg/L chronic aquatic life criteria Forms objectionable sludge deposits during spring runoff 	
Lead*	High Flow	12	16 to 68	<ul style="list-style-type: none"> Consistently exceeds 3.2 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	11	<3 to 21	<ul style="list-style-type: none"> Usually exceeds 5.3 µg/L chronic aquatic life criteria 	
	Early Runoff	5	76 to 330	<ul style="list-style-type: none"> Consistently exceeds 12.9 µg/L chronic aquatic life criteria 	
Manganese	High Flow	12	200 to 1700	<ul style="list-style-type: none"> Consistently exceeds 50 µg/L domestic use 	17.30.623(2)(h)(i) - WQB-7 17.30.601
	Low Flow	14	360 to 9900	<ul style="list-style-type: none"> Consistently exceeds 50 µg/L domestic use 	
	Early Runoff	5	3120 to 7300	<ul style="list-style-type: none"> Consistently exceeds 50 µg/L domestic use 	
Zinc*	High Flow	10	660 to 3000	<ul style="list-style-type: none"> Consistently exceeds 120 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	11	560 to 17000	<ul style="list-style-type: none"> Consistently exceeds 169 µg/L chronic aquatic life criteria 	
	Early Runoff	5	8000 to 14000	<ul style="list-style-type: none"> Consistently exceeds 304 µg/L chronic aquatic life criteria 	

Includes high flow, low flow and early runoff water quality data from 1996 through 2001 period.

Evaluation of exceedences based on total recoverable fraction (except for aluminum which is based on dissolved fraction).

n- number of measurements

*-aquatic criteria based on actual hardness of water sample.

Table 4-3 Mike Horse Creek Drainage Seasonal Metals Impairment Summary for Monitoring Sites BRSW-4 and BRSW-22.

Metal	Season	N	Concentration Range µg/L	EXCEEDENCE SUMMARY	Water Quality Standards References
Aluminum	High Flow	14	<50 to 130	<ul style="list-style-type: none"> 2 exceedences of 87 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i)-WQB-7 17.30.637(1)(d)
	Low Flow	13	<50 to 87	<ul style="list-style-type: none"> Consistently less than 87 µg/L chronic aquatic life criteria 	
	Early Runoff	6	<50 to 7700	<ul style="list-style-type: none"> 3 exceedences of 87 µg/L chronic aquatic life criteria Forms objectionable sludge deposits during spring runoff 	
Cadmium*	High Flow	14	12 to 62.7	<ul style="list-style-type: none"> Consistently exceeds 0.27 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	11	14 to 150	<ul style="list-style-type: none"> Consistently exceeds 0.53 µg/L chronic aquatic life criteria 	
	Early Runoff	4	110 to 186	<ul style="list-style-type: none"> Consistently exceeds 0.61 µg/L chronic aquatic life criteria 	
Copper*	High Flow	14	71 to 1780	<ul style="list-style-type: none"> Consistently exceeds 9.3 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	11	24 to 600	<ul style="list-style-type: none"> Consistently exceeds 20.4 µg/L chronic aquatic life criteria 	
	Early Runoff	4	240 to 4450	<ul style="list-style-type: none"> Consistently exceeds 23.9 µg/L chronic aquatic life criteria Forms objectionable sludge deposits during spring runoff 	
Iron	High Flow	14	<20 to 940	<ul style="list-style-type: none"> 4 exceedences of 300 µg/L domestic use 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d) 17.30.637(1)(a) 17.30.601
	Low Flow	11	<20 to 840	<ul style="list-style-type: none"> 2 exceedences of 300 µg/L domestic use 	
	Early Runoff	4	20 to 950	<ul style="list-style-type: none"> 1 exceedences of 300 µg/L domestic use Forms objectionable sludge deposits during spring runoff 	
Lead*	High Flow	14	24 to 217	<ul style="list-style-type: none"> Consistently exceeds 3.2 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	11	12 to 140	<ul style="list-style-type: none"> Consistently exceeds 10.2 µg/L chronic aquatic life criteria 	
	Early Runoff	4	110 to 199	<ul style="list-style-type: none"> Consistently exceeds 12.9 µg/L chronic aquatic life criteria 	
Manganese	High Flow	14	340 to 6700	<ul style="list-style-type: none"> Consistently exceeds 50 µg/L domestic use 	17.30.623(2)(h)(i) - WQB-7 17.30.601
	Low Flow	11	97 to 40000	<ul style="list-style-type: none"> Consistently exceeds 50 µg/L domestic use 	
	Early Runoff	4	3100 to 7400	<ul style="list-style-type: none"> Consistently exceeds 50 µg/L domestic use 	
Zinc*	High Flow	14	1800 to 14000	<ul style="list-style-type: none"> Consistently exceeds 120 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	11	3100 to 67000	<ul style="list-style-type: none"> Consistently exceeds 26.4 µg/L chronic aquatic life criteria 	
	Early Runoff	4	14000 to 27600	<ul style="list-style-type: none"> Consistently exceeds 304 µg/L chronic aquatic life criteria 	

Includes high flow, low flow and early runoff water quality data from 1996 through 2001 period.

Evaluation of exceedences based on total recoverable fraction (except for aluminum which is based on dissolved fraction).

n- number of measurements

*-aquatic criteria based on actual hardness of water sample.

As previously stated and summarized in Tables 4-2 and 4-3, water quality exceedences for certain parameters in Beartrap Creek and Mike Horse Creek are more frequent under early runoff or high flow conditions as compared with low flow conditions. For example, the Beartrap Creek iron data show that, out of 26 measurements, 4 exceedences of the domestic use narrative standard were recorded, with 3 of the exceedences occurring under early spring runoff conditions. Similarly, for copper, 15 samples collected during early runoff and high flow conditions all exceeded chronic aquatic life standards, while only 1 sample out of 12 exceeded the chronic standard under low flow conditions. For other parameters, however (i.e., cadmium, manganese and zinc), concentrations consistently exceed one or more applicable water quality standards during all flow conditions.

In addition to impairments caused by elevated metals concentrations in the water column, metal precipitates form objectionable sludges in Mike Horse and Beartrap Creeks. Based on appearance, these sludges are believed to consist primarily of iron-hydroxide precipitates with copper and aluminum precipitates occurring in upper Mike Horse Creek as well. The precipitates may impact aquatic life in these stream segments by impacting the stream substrate.

Streambed Sediments

Asarco collected one streambed sediment sample from the listed portion of Beartrap Creek in 1993 as part of their Phase I investigation of the UBMC (PTI, 1993). The sample was a composite of four subsamples collected at a 0-2" depth interval across a stream channel transect. According to the Phase I investigation report, the sediment sample location (designated MH-18) was approximately 1000 feet upstream of the confluence of Beartrap and Anaconda Creeks, corresponding to the stream reach between sites BRSW-23 and BRSW-39 (Figure 4-1). The sample was analyzed for total metals concentrations, with the analytical results shown in Table 4-4.

Table 4-4 also includes analytical results from a sediment sample collected in 1989 from Mike Horse Creek (Moore, 1990). This sample was collected in the vicinity of surface water monitoring site BRSW-22. The Mike Horse Creek sample was filtered in the field to exclude sediments greater than 63 microns in size.

Table 4-4 Mike Horse and Beartrap Creek Stream Sediment Metals Concentrations.

Parameter	Concentration (mg/Kg)	
	Beartrap Creek	Mike Horse Creek
Aluminum	5305	10800
Silver	43	NA
Arsenic	400	180
Cadmium	46	310
Cobalt	36	Na
Chromium	9.4	Na
Copper	1736	11570
Iron	117500	341000

Table 4-4 Mike Horse and Beartrap Creek Stream Sediment Metals Concentrations.

Parameter	Concentration (mg/Kg)	
	Beartrap Creek	Mike Horse Creek
Manganese	6495	8.296
Nickel	29	83
Lead	8618	3095
Zinc	8668	149448

Beartrap Creek sediment sample collected at site MH-18 as part of Phase I Investigation (PTI, 1993)

Mike Horse Creek sediment sample collected at site T-215.0 (near BRSW-22) by J.N. Moore, 1990.

NA- Not Analyzed

Results from the Beartrap Creek and Mike Horse Creek sediment samples indicate the stream sediments contain elevated concentrations of several metals, including arsenic, cadmium, copper, iron, manganese, lead, and zinc. These values are significantly greater than published guidance values denoting potentially harmful conditions for aquatic biota from streambed sediments (Jones et al., 1997; Long and Morgan, 1990). Based on these results, metals concentrations in stream sediments likely contribute to impairment of beneficial uses in Beartrap and Mike Horse Creeks. It is possible that current sediment metals concentrations are less than those shown in Table 4-4 due to recent mine reclamation activities, although more recent sediment data is not available.

4.3 Source Characterization

4.3.1 Beartrap Creek and Mike Horse Creek Metals Source Inventory

Sources of metals loading to the listed portion of Beartrap Creek drainage have been well documented through the UBMC site characterization program and reclamation activities (Hydrometrics, 2000, 2001a, 2002). Identified sources of metals loading to the listed stream segment include:

- Acidic surface seepage (and possibly subsurface seepage) water originating from the toe of the Mike Horse Tailings Dam;
- Surface water inflow from Mike Horse Creek;
- Dispersed mine waste located along the Beartrap Creek floodplain; and
- Mine waste dumps associated with a small mining prospect (the Flosse and Louise Mine) located along the Beartrap Creek drainage bottom.

The sources identified above (and shown on Figure 4-1) are believed to represent the predominant sources of metals loading to the listed segment of Beartrap Creek. Additional metals loading sources may exist however, including other mining-related sources, recharge of mineralized groundwater to the creek, and/or natural background metals loading.

Sources of metals loading to Mike Horse Creek identified through past site characterizations activities include:

- An area of acidic seepage in the upper Mike Horse area; and
- The lower Mike Horse Mine waste piles (Figure 4-1).

Significant metals loading to Mike Horse Creek has been documented from both of these source areas (Hydrometrics, 2000, 2001a, 2002). As with the Beartrap Creek, it is possible that other metals loading sources exist in Mike Horse Creek drainage beyond the documented sources listed above. For purposes of this water quality restoration plan, it is anticipated that all sources of metals loading in Mike Horse and Beartrap Creek drainages (including potential sources not currently identified) will be addressed through the ongoing UBMC mine reclamation program and temporary standards implementation plan as required by applicable water quality regulations (MCA 75-5-312 (3)(c)).

4.3.2 Metals Source Analysis

Detailed seasonal surface water and groundwater sampling performed in Beartrap Creek drainage in conjunction with the UBMC mine reclamation program provides insight into the impact to surface water quality from the various metals loading sources (Hydrometrics, 2001a, 2002). For instance, this sampling has shown that concentrations (and loads) of most metals are greatest during the early spring runoff (April) period. Total recoverable copper concentrations at site BRSW-23 in 2001 ranged from 350 µg/L in April, to 72 µg/L in May, 53 µg/L in June, and 4 µg/L in October (Table 4-5). Zinc concentrations varied from 12,000 µg/L to 1,200 µg/L to 990 µg/L to 740 µg/L during this same time period. Diurnal variations in copper concentrations have also been documented in Beartrap Creek during the April early runoff period. For example, copper concentrations ranged from 180 to 490 µg/L, respectively, in two samples collected from site BRSW-38 in the morning and afternoon of April 25, 2001 (Appendix B).

Table 4-5 Metals Loading Trends for Early Runoff, High Flow and Low Flow Conditions in Beartrap Creek.

	Flow cfs	Copper Conc. µg/L	Copper Load lb/Day	Zinc Conc. µg/L	Zinc Load lb/Day
4/25/01	0.74	350	1.4	12,000	48
5/22/01	4.2	72	1.6	1,200	27.2
6/26/01	3.6	53	1.03	990	19.2
10/4/01	0.23	4	.005	740	0.92

Metals concentrations and loads based on total recoverable fraction.

Water quality data from site BRSW-23 (see Figure 4-1)

The exceptionally high April metals concentrations in Beartrap Creek may result from flushing of metal salts from the dispersed floodplain tailings. Oxidation of metal-sulfide minerals (primarily pyrite) during the dry summer and fall, coupled with soil moisture evaporation, produces a coating of metal-sulfate salts on the ground surface. It is likely that these highly soluble metal-salts are flushed into the creek (and possibly to the shallow alluvial water table) during melting of the drainage-bottom snowpack. The UBMC Temporary Standards Implementation Plan identifies the dispersed floodplain tailings as a source of metals loading to Beartrap Creek. The implementation plan schedule includes reclamation of the floodplain tailings (Hydrometrics, 2000).

Seepage from the Mike Horse Tailings Impoundment has been monitored numerous times to quantify seepage water quality and associated metals loading rates. Based on May 2001 sampling results, metals loads in the tailings dam seepage totaled 0.04 lb/day for cadmium, 0.16 lb/day for copper, 0.58 lbs/day for iron, 0.25 lb/day for lead, 4.5 lbs/day for manganese, and 7.8 lb/day for zinc (Hydrometrics, 2002). The cumulative seepage loads equate to 25% of the cadmium load, 10% of the copper load, 35% of the iron load, 40% of the lead load, 32% of the manganese load, and 29% of the zinc load in Beartrap Creek as measured at site BRSW-23 at that time (Figure 4-1).

Metals loading from Mike Horse Creek to Beartrap Creek has been quantified through extensive synoptic surface water sampling and metals loading analyses in the Upper Blackfoot River drainage. Seasonal surface water sampling and streamflow monitoring near the mouth of Mike Horse Creek (monitoring site BRSW-35, Figure 4-1), and at downstream sites on Beartrap Creek, allow determination of the relative load contribution from Mike Horse Creek to Beartrap Creek. Figure 4-2 depicts the seasonal loading rates (in pounds per day) for cadmium, copper, lead and zinc at monitoring site BRSW-35 near the mouth of Mike Horse Creek, site BRSW-23 in Beartrap Creek below the confluence with Mike Horse Creek, and at site BRSW-38 near the mouth of Beartrap Creek (Figure 4-1). As shown in Figure 4-2, metals loading from Mike Horse Creek typically accounts for a significant portion of the metals load present in the listed portion of Beartrap Creek. During May and June 2001, metal loads calculated for Mike Horse Creek site BRSW-35 accounted for an average of 73% of the downstream metal loads at Beartrap Creek site BRSW-23, and 61% of the load at Beartrap Creek site BRSW-38. For example, the May 2001 copper load at Mike Horse Creek site BRSW-35 (1.1 lb/day) accounted for 68% of the load measured at site Beartrap Creek site BRSW-23 (1.6 lb/day).

During the April 2001 monitoring event, metal loads in Mike Horse Creek actually exceeded those measured in Beartrap Creek. The copper load for April 2001 was 2.6 lb/day at BRSW-35 (Mike Horse Creek) and 1.4 lb/day at BRSW-23 (Beartrap Creek). This loading decrease suggests removal of metals from the water column to streambed sediments through precipitation and/or adsorption is likely occurring in Beartrap Creek (downstream decreases in streamflow, which could also cause the observed load decrease, were not observed at the time of the sampling). The phase transfer of metals from water to sediments is consistent with the elevated concentrations of metals observed in Beartrap Creek sediments (Table 4-4), and with visual observations of metal precipitate coatings on the streambed.

4.4 Restoration Targets, TMDLs and Load Allocations

Water quality restoration targets and TMDLs are established below based on applicable water quality standards and documented streamflow rates in Beartrap Creek and Mike Horse Creek. Target and TMDL calculation sites include monitoring site BRSW-23 in Beartrap Creek, and site BRSW-22 in Mike Horse Creek. Due to the large seasonal fluctuations in metals concentrations and loads, specific restoration targets and TMDLs are developed for high flow, low flow, and early spring runoff conditions, which typically occur in April.

4.4.1 Metals Restoration Targets

Water quality restoration targets for metals in Beartrap Creek and Mike Horse Creek are listed in Table 4-6. Restoration targets are established for the metals aluminum (Mike Horse Creek only), cadmium, copper, iron, lead, manganese and zinc since extensive testing has indicated that these metals exceed applicable water quality standards on at least a periodic basis. Due to the common primary source for the elevated metals concentrations in these two drainages (historic mining), it is assumed that restoration activities aimed at these metals will also address any other metals that may occur at elevated levels. Restoration targets for cadmium, copper, lead and zinc are based on the applicable numeric water quality standards associated with chronic aquatic life criteria with appropriate hardness modifications. Basing restoration targets on the chronic aquatic criteria will ensure that other numeric criteria (human health, acute aquatic life) are met since the chronic criteria are the most stringent (lowest concentration). The restoration targets for iron and manganese are based on the 300 µg/L and 50 µg/L guidance values for drinking water use support in WQB-7 (MDEQ, 2001b). Iron also has an upper limit target of 1000 µg/l based on the chronic criteria for aquatic life support.

Hardness values used in calculating the targets are based on actual measured values and include 100 mg/L (as CaCO₃) for high flow, 150 mg/L for low flow, and 250 mg/L during early runoff conditions in Beartrap Creek, and 100 mg/L during high flow, 250 mg/L during low flow, and 300 mg/L during early runoff conditions in Mike Horse Creek. Because it is unknown what the actual hardness values will be under restoration conditions, the target values listed in Table 4-6 for these metals represent estimated values at the various flow conditions. The actual targets will be based on actual in-stream hardness values as measured at the time of sampling. Appendix A of this document provides an example of the hardness adjustment equation for chronic aquatic life support standards.

Compliance for the water quality targets will be based on high and low flow water quality data, with no more than one measurement of the concentration for a particular metal exceeding the chronic criteria by more than 10%. This approach is consistent with MDEQ guidance for making beneficial use support determinations (MDEQ, 2002). In evaluating compliance with the iron and manganese drinking water use targets, consideration should be given to the level and frequency of exceedences, and whether or not the exceedences interfere with the uses specified in the surface water quality standards (ARM 16.30.623). Appendix A provides additional discussion for evaluating compliance with the iron and manganese targets.

In addition to the water chemistry-based targets, iron has an additional target in Beartrap Creek and Mike Horse Creek of no visible streambed deposits of iron precipitates resulting from human caused conditions. This same target is applied to copper and aluminum in Mike Horse Creek. Furthermore, metals concentrations in sediments cannot impede beneficial uses, with focus on aquatic life support. This target applies to all metals, either individually or in combination, which may occur at potentially toxic concentrations in stream sediments. Assessment of stream sediment concentrations and beneficial use support conditions will be consistent with the stream sediment screening approach discussed in Section 1.2.3.

Table 4-6 Water Quality Restoration Targets for Metals in Beartrap Creek and Mike Horse Creek.

Pollutant	Beartrap Creek Target(s)	Mike Horse Creek Target(s)	Limiting Beneficial Use
Aluminum	NA	87 ug/l (all flows) No visible stream bed deposits associated with controllable human sources (all flows)	Aquatic Life (chronic) Aquatic life/Aesthetics
Cadmium ¹	0.37 ug/l (low flow) 0.27 ug/l (high flow) 0.53 ug/l (early runoff)	0.53 ug/l (low flow) 0.27 ug/l (high flow) 0.61 ug/l (early runoff)	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life (chronic)
Copper ¹	13.2 ug/l (low flow) 9.3 ug/l (high flow) 20.4 ug/l (early runoff)	20.4 ug/l (low flow) 9.3 ug/l (high flow) 23.9 ug/l (early runoff) No visible stream bed deposits associated with controllable human sources (all flows)	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life (chronic) Aquatic life/Aesthetics
Iron	300 ug/l 1000 ug/l (all flows) No visible stream bed deposits associated with controllable human sources (all flows)	300 ug/l 1000 ug/l (all flows) No visible stream bed deposits associated with controllable human sources (all flows)	Drinking water (domestic use) Aquatic life (chronic) Aquatic life/Aesthetics
Lead ¹	5.3 ug/l (low flow) 3.2 ug/l (high flow) 10.2 ug/l (early runoff)	10.2 ug/l (low flow) 3.2 ug/l (high flow) 12.9 ug/l (early runoff)	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life (chronic)
Manganese	50 ug/L	50 ug/L	Drinking water (domestic use)
Zinc ¹	169 ug/l (low flow) 120 ug/l (high flow) 260.4 ug/l (early runoff)	260 ug/l (low flow) 120 ug/l (high flow) 304 ug/l (early runoff)	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life (chronic)
Metals	No metal concentrations in sediment that may impede beneficial uses. Macroinvertebrate and periphyton communities must show no impairment from metals.	No metal concentrations in sediment that may impede beneficial uses. Macroinvertebrate and periphyton communities must show no impairment from metals.	Aquatic Life Aquatic Life

Notes: 1. Targets are estimated based on predicted hardness values of 100 mg/L during high flow, 150 mg/L at low flow, and 250 mg/L during early runoff (as CaCO₃) in Beartrap Creek and 100 mg/L during high flow, 250 mg/L during low flow, and 300 mg/L during early runoff in Mike Horse Creek after completion of restoration activities; actual targets will be determined by hardness at time of sampling as defined in Appendix A.

As an additional measure of overall beneficial use attainment, a restoration target for macroinvertebrate and periphyton communities also applies. Metals concentrations must not impede attainment of full support conditions when compared to a known reference condition using standard MDEQ protocols (reference Appendix A). The monitoring locations for compliance with the sediment chemistry and biota targets will be the same as discussed above for water chemistry sampling, although it should be noted that such sampling typically occurs once at each location during low flow conditions

It is important to note that the above targets represent minimum requirements for protecting beneficial uses identified within Montana's Surface Water Quality Standards, and are based on interpretations of available data presented within this plan. Other regulatory programs with water quality protection responsibilities may impose additional requirements to ensure full compliance with all appropriate local, State and Federal laws.

4.4.2 Beartrap Creek and Mike Horse Creek Metals TMDL

Similar to the TMDL development approach utilized for Sandbar and Poorman creek drainages, metals TMDLs for Beartrap Creek and Mike Horse Creek are designed to ensure compliance with water quality standards under any streamflow rates and potential restoration targets. Metals TMDLs are defined by Equation 4-1.

Equation 4-1: *Total Maximum Daily Load (lb/day) = (X ug/l)(Y cfs)(0.0054)*

where:

X = the applicable water quality numeric standard (target) in ug/l with hardness adjustments where applicable (see above discussion on targets);

Y = streamflow in cubic feet per second;

(0.0054) = conversion factor

Tables 4-7 and 4-8 include TMDLs for documented high flow, low flow, and early spring runoff conditions in Beartrap Creek and Mike Horse Creek, respectively. The calculated TMDLs are based on the restoration targets presented in Table 4-6, and the average measured streamflow rates from monitoring site BRSW-23 in Beartrap Creek, and site BRSW-22 in Mike Horse Creek for the specified flow condition. The TMDLs presented in Tables 4-7 and 4-8 apply to the specified conditions only, with actual TMDLs being dependent on the stream loading capacity (which in turn is determined by the flow rate and water hardness) at any given location and time. In this manner, the TMDLs defined by Equation 4-1 address seasonal variability in streamflow and water chemistry (hardness) in the metals impacted segments of Beartrap and Mike Horse Creeks.

Some additional notes concerning the Beartrap Creek and Mike Horse Creek TMDLs and the target conditions they are intended to satisfy include:

- For iron, the TMDL based on the 300 ug/l drinking water/domestic use support condition is expected to satisfy the additional target of no visible stream bed deposits associated with iron hydroxide precipitates from human causes. This is also true of aluminum and copper in Mike Horse Creek, whereby meeting the aluminum and copper TMDLs is expected to eliminate visible streambed deposits from these metals.

- Based on seasonal and other considerations associated with the iron and manganese drinking water/domestic use support criteria, a higher TMDL may be acceptable for both iron and manganese as long as other target criteria associated with visible stream deposits, sediment toxicity, biota support, and chronic aquatic life criteria are satisfied.
- Meeting the cadmium, copper, iron, lead, manganese and zinc TMDLs is expected to satisfy the restoration targets associated with sediment toxicity (Table 4-6) for two reasons. First, restoration activities designed to address existing sources of water quality impairment (acidic seepage, mine waste piles, floodplain tailings), should also eliminate the source(s) of elevated sediment concentrations. Secondly, as metal loads in Beartrap and Mike Horse Creeks are reduced to TMDL levels, the fine-grained metals-bearing sediments likely will flush through the system during high flow periods via typical sediment transport processes. As source areas are reclaimed through the ongoing UBMC reclamation program, the displaced sediments will be replaced with fewer metals-bearing sediments. Also, since other metals which may occur at elevated concentrations in sediments are likely derived from the same mining-related sources as cadmium, copper, iron, lead, manganese and zinc, meeting the TMDLs for these metals are expected to address sediment toxicity issues which may exist for other metals in Beartrap and Mike Horse Creeks. The response of sediment chemistry to implementation of the metals TMDLs will be documented through post-implementation sediment testing (Section 6.3).
- Meeting all of the metals TMDLs is expected to eliminate any metals-related impediments to satisfying the target associated with macroinvertebrate and periphyton communities being at full support conditions in comparison to reference conditions.
- Meeting the metals TMDLs should address diurnal variations in metals concentrations observed in Beartrap Creek drainage during early spring runoff since the suspected source of the diurnal variations (the floodplain tailings) will need to be addressed to meet the TMDLs.

Tables 4-7 and 4-8 also provide estimates of the percent total load reduction needed to meet the TMDLs and water quality restoration targets under the various flow conditions. These estimates are based on the seasonal streamflow rates and metals concentrations measured at monitoring site BRSW-23 in Beartrap Creek and BRSW-22 in Mike Horse Creek from 1996 through 2001 (Figure 4-1). For example, the required load reduction for cadmium in Beartrap Creek is greater than 95% during both high flow and low flow conditions, and greater than 98% during early runoff conditions in order to meet the TMDL and water quality restoration targets established at site BRSW-23. Note that no load reductions are required for copper under low flow conditions, and for iron under high and low flow conditions (Table 4-7). This is due to the fact that, although these metals have on occasion exceeded applicable water quality standards under these flow conditions (Table 4-2), the average of all measurements obtained for these flow conditions (and used in estimating the percent load reduction required), are less than the applicable water quality standards. Therefore, these metals are currently meeting the flow-specific TMDLs the majority of the time.

Table 4-7 Beartrap Creek TMDLs and Required Load Reductions for Metals at Specified High Flow, Low Flow, and Early Runoff Conditions at Monitoring Location BRSW-23.

Pollutant	Target (ug/l)	Mean Low Flow (0.30 cfs) TMDL¹ (lb/day)	Mean High Flow (7.51 cfs) TMDL¹ (lb/day)	Mean Early Runoff (1.27 cfs) TMDL¹ (lb/day)	% Total Load Reduction Needed to Meet TMDLs and Targets
Cadmium*	0.4 (low flow) 0.3 (high flow) 0.6 (early runoff)	0.0007	0.012	0.0041	95.4% (low flow) 95.5% (high flow) 98.3% (early runoff)
Copper*	13.2 (low flow) 9.3 (high flow) 23.9 (early runoff)	0.021	0.376	0.164	0% (low flow); 84.0% (high flow) 88.9% (early runoff)
Iron	300 (low flow) 300 (high flow) 300 (early runoff)	0.488	12.13	2.05	0% (low flow); 0% (high flow) 76.4% (early runoff)
Lead*	5.3 (low flow) 3.2 (high flow) 12.9 (early runoff)	0.009	0.129	0.089	35.8% (low flow); 87.7% (high flow) 89.2% (early runoff)
Manganese	50 ug/L (low flow) 50 ug/L (high flow) 50 ug/L (early runoff)	0.081	2.022	0.342	97.2% (low flow); 92.3% (high flow) 98.7% (early runoff)
Zinc*	169 ug/l (low flow) 120 ug/l (high flow) 304 (early runoff)	0.275	4.854	2.079	93.9% (low flow) 91.9% (high flow) 97.0% (early runoff)

¹ Mean high flow, low flow and early runoff values based on average of seasonal flow measurements from site BRSW-23 from 1996 through 2001.

Early runoff data from April.

*- TMDL based on water hardness of 100 mg/L for high flow, 150 mg/L for low flow, and 250 mg/L (as CaCO₃) for early runoff conditions, based on 1996-2001 sampling results.

Table 4-8 Mike Horse Creek TMDLs and Required Load Reductions for Metals at Specified High Flow, Low Flow, and Early Runoff Conditions at Monitoring Location BRSW-22.

Pollutant	Target (ug/l)	Mean Low Flow (0.052 cfs) TMDL ¹ (lb/day)	Mean High Flow (1.29 cfs) TMDL ¹ (lb/day)	Mean Early Runoff (0.35 cfs) TMDL ¹ (lb/day)	% Total Load Reduction Needed to Meet TMDLs and Targets
Aluminum	87 (low flow) 87 (high flow) 87 (early runoff)	0.024	0.61	0.16	-43% (low flow) -45% (high flow) -36% (early runoff)
Cadmium*	0.4 (low flow) 0.3 (high flow) 0.6 (early runoff)	0.00015	0.0019	0.0012	99% (low flow) 99% (high flow) 99% (early runoff)
Copper*	13.2 (low flow) 9.3 (high flow) 23.9 (early runoff)	0.0057	0.065	0.045	68% (low flow); 97% (high flow) 98% (early runoff)
Iron	300 (low flow) 300 (high flow) 300 (early runoff)	0.084	2.09	0.57	-36% (low flow); -48% (high flow) 43% (early runoff)
Lead*	5.3 (low flow) 3.2 (high flow) 12.9 (early runoff)	0.003	0.022	0.024	76% (low flow); 94% (high flow) 90% (early runoff)
Manganese	50 ug/L (low flow) 50 ug/L (high flow) 50 ug/L (early runoff)	0.014	0.348	0.095	99% (low flow); 96% (high flow) 99% (early runoff)
Zinc*	169 ug/l (low flow) 120 ug/l (high flow) 304 (early runoff)	0.073	0.840	0.575	98% (low flow) 97% (high flow) 98% (early runoff)

¹ Mean high flow, low flow and early runoff values based on average of seasonal flow measurements from site BRSW-22 from 1996 through 2001.

Early runoff data from April.

*- TMDL based on water hardness of 100 mg/L for high flow, 250 mg/L for low flow, and 300 mg/L (as CaCO₃) for early runoff conditions, based on 1996-2001 sampling results.

Negative value for “% Total Load Reduction Needed” indicates standard is being met on average although periodic exceedences do occur.

The metals TMDLs and required load reductions presented in Tables 4-7 and 4-8 apply only to the specific streamflow rates and restoration targets used in their calculation. The degree to which these particular conditions represent typical high flow, low flow, and early runoff conditions in Beartrap and Mike Horse Creeks is unknown. It is likely that TMDLs calculated from future data may vary significantly from these examples. Ultimately, the TMDL is equivalent to the load of a particular pollutant that the creeks can support without exceeding B-1 water quality standards at a given flow as calculated from equation 4-1. General information on calculations of TMDLs is included in Appendix A. Available water quality data used in calculations of TMDLs and load reduction requirements are in Appendix C.

4.4.3 Beartrap Creek and Mike Horse Creek Load Allocations

In light of the ongoing mine reclamation activities at the Upper Blackfoot Mining Complex, and the fact that the portions of Beartrap and Mike Horse Creeks to which the TMDLs apply are subject to the UBMCM reclamation requirements, a performance-based approach for allocation of metal loads has been adopted for Beartrap Creek and Mike Horse Creek. The performance-based approach recognizes the ongoing mine reclamation activities in the drainages, and the regulatory programs and cleanup commitments currently in place as part of the Temporary Water Quality Standards process. As stipulated in the Montana water quality regulations (MCA 75-5-312), before the Board of Environmental Review can grant temporary standards to a water body, the petitioner must submit an implementation plan designed to eliminate the water quality limiting factors to the extent considered achievable, and a schedule for implementing the plan that ensures that the water quality standards are met as soon as reasonably practicable, and in no event later than the time allowed by the board in the temporary standards. It is believed that all significant human-caused sources of metals loading to the metals-impaired segments of Beartrap and Mike Horse Creeks are identified in, and will be addressed by, the Temporary Standards Implementation Plan. The implementation plan requires post-reclamation water quality monitoring be conducted for the purpose of documenting water quality improvements in Beartrap Creek (as well as Mike Horse Creek) in response to mine reclamation activities. In the event that post-reclamation monitoring shows that B-1 classification standards (and thus the water quality restoration targets and TMDLs) are not being met, the causes and sources for continued water quality impairments must be identified and mitigated (except natural sources) to the extent considered achievable. Therefore, the Temporary Standards regulations include built-in contingencies to ensure that all human-caused sources of water quality impairment to the metals-impaired segments of Beartrap and Mike Horse Creeks are addressed.

The Temporary Standards Implementation Plan identifies the following known or suspected sources of metals loading to Beartrap and Mike Horse Creeks:

- Mike Horse Creek Drainage
 - Upper Mike Horse Seepage area
 - Lower Mike Horse mine waste
- Mike Horse Tailings Impoundment
- Beartrap Creek Floodplain Tailings
- Flosse and Louise Mine

Each of these source areas is described in detail in various reports (Hydrometrics, 1999, 2000, 2001a, 2002). Following is a brief discussion of each source, and restoration options and schedules included in the Temporary Standards Implementation Plan. The complete Implementation Plan is included in Appendix B.

Mike Horse Creek Drainage: Known sources of metals loading to Mike Horse Creek (and thus to the listed portion of Beartrap Creek) include; the Upper Mike Horse Creek Seepage Area, and the Lower Mike Horse Mine Waste Area (Figure 4-1). Possible restoration actions included in the Temporary Standards Implementation Plan for the Upper Mike Horse Seepage Area include (but are not limited to): removal of the previously reclaimed Upper Mike mine waste piles if shown to be a source of metals loading to the seepage water; construction of surface water and/or groundwater diversions around the area; or treatment of seepage water. Reclamation options listed in the Implementation Plan for the Lower Mike Horse Mine Waste include complete or partial mine waste removal and placement in an engineered repository, and in-place reclamation of mine waste through mine waste regrading, amendment, and/or covering.

Mike Horse Tailings Impoundment: As summarized above (Section 4.3) and described in detail in previous reports (Hydrometrics, 2002), surficial seepage from the Mike Horse Tailings Impoundment is a documented source of metals loading to Beartrap Creek. The Temporary Standards Implementation Plan addresses metals loading from the tailings impoundment and outlines possible actions for mitigation of this loading source. Possible actions include, but are not limited to: revegetating the dam face; sealing the inner dam face to reduce seepage; capture of seepage water at the dam toe for treatment; removal of seasonally exposed tailings along the tailings pond beach which are subject to oxidation and release of metals and acidity; manipulating pond water levels to either reduce seepage or flood exposed tailings; partial sealing of the pond bottom; and partial or complete removal of the impoundment. The implementation plan also addresses the geotechnical stability of the dam and recognizes the possible need for an emergency overflow spillway. A preliminary evaluation of the dam design and stability and spillway requirements has been completed (Hydrometrics, 2001b).

Beartrap Creek Floodplain Tailings: The dispersed floodplain tailings occur along the Beartrap Creek drainage bottom from the Mike Horse Tailings Dam to the mouth of Beartrap Creek (Figure 4-1). Year 2000 and 2001 implementation plan activities in Beartrap Creek drainage have focused on characterizing the lateral and vertical distribution of tailings, the tailings physical and chemical characteristics, and evaluating specific modes of metals loading from the tailings to the creek (Hydrometrics, 2002). Mitigation alternatives identified in the implementation plan for the dispersed floodplain tailings include, but are not limited to: complete or partial tailings removal and placement in an engineered repository; partial tailings removal with construction of settling basins/wetland structures along the drainage bottom for physical and chemical stabilization and/or water treatment; consolidation of tailings with local closure; in-place reclamation through soil amendment and revegetation.

Flosse and Louise Mine: The Flosse and Louise Mine is located along the impaired segment of the Beartrap Creek drainage bottom (Figure 4-1). Unlike other property holdings within the UBM, the Flosse and Louise patented mine claims are not under Asarco ownership nor are they National Forest System lands. Mine features include a collapsed adit and an approximately

1,500 cubic yard waste rock dump. Asarco has conducted characterization activities at the Flosse and Louise Mine in the past two years including mine waste sampling, trenching and subsurface exploration, and surface water sampling in the vicinity of the mine. Reclamation alternatives are not specified in the implementation plan pending discussions and agreements with the landowner, but will likely include complete or partial mine waste removal and placement in an engineered repository, or in-place amendment and closure.

All identified sources of metals loading in Beartrap Creek and Mike Horse Creek as listed above are addressed and scheduled for reclamation in the Temporary Standards Implementation Plan (Appendix B). As such, completion of the implementation plan program is expected to result in attainment of the water quality restoration targets listed in Table 4-6 and the metals TMDLs. If future water quality monitoring as required by the implementation plan shows otherwise, additional site investigation and reclamation activities will be required under the implementation plan to address all human-caused sources of metals loading which may individually or collectively cause B-1 water quality standards for metals to be exceeded. The ultimate goal of the temporary water quality standards of attaining B-1 water quality standards, to the extent considered achievable, should ensure that the performance-based load allocation adopted for Beartrap and Mike Horse Creeks results in successful attainment of the metals TMDL goals and water quality restoration targets. This includes appropriate implementation monitoring and maintenance of restoration efforts to ensure success.

If the performance based allocation approach discussed above should undergo significant delays or otherwise run into significant implementation problems, then a source-specific category allocation approach will apply. Under this scenario, the load allocations for mining related sources as well as natural background sources will be set equal to the TMDL as defined by Equation 4-1 to be consistent with numeric B-1 water quality standards.

SECTION 5.0

RESTORATION PLAN FOR THE BLACKFOOT RIVER

The Blackfoot River flows through the Headwaters Planning Area from the confluence of Anaconda Creek and Beartrap Creek (the beginning of the Blackfoot River) to the confluence with Nevada Creek. Of this approximately 60 mile stretch of river, the upper 16.4 miles (from the headwaters to the confluence with Landers Fork) is listed as impaired for metals (Figure 5-1) on the most recent 2002 303(d) list. Relevant features of this listed stream segment include a large natural marsh system, which occupies much of the upper half of the drainage bottom, and the Upper Blackfoot Mining Complex (UBMC). The upper 1.2 miles of river (upstream of the confluence with Pass Creek) are included in the current UBMC mine reclamation program.

Sections 5.1 through 5.4 address TMDL development and restoration plan development for the section of the Blackfoot River above Landers Fork. The upper 1.2 miles of this river segment upstream of the confluence with Pass Creek is addressed separately within Sections 5.1 through 5.4. This is due to the significant differences in the physical and chemical characteristics upstream of Pass Creek as compared to the river segment from Pass Creek to Landers Fork, and the ongoing mine reclamation activities and Temporary Standards Implementation Plan requirements focused on the upper river segment.

Section 5.5 addresses metals TMDL development and restoration plan development for the section of the Blackfoot River from Landers Fork to Nevada Creek.

5.1 Available Water Quality Data for the Blackfoot River upstream of Landers Fork

Significant water quality data has been collected for the portion of the Blackfoot River from the Landers Fork upstream to the headwaters. A comprehensive review identified five general sources of water quality information including the UBMC database (data collected in conjunction with the UBMC mine reclamation program), the EPA-maintained STORET database, an USGS-maintained database, the MDEQ-maintained STOREASE database, and miscellaneous data collection studies/reports by various entities including the USGS, University of Montana, and private companies. Available water quality data from these sources was reviewed to determine the most appropriate data for use in evaluating impairment conditions in the Blackfoot River, and determine restoration targets and TMDLs.

The water quality data were screened for applicability and suitability for the intended uses according to the following criteria:

- Date of data collection;
- Sampling location; and
- Reported parameters.

The water quality data set selected for evaluation of impairment conditions consists of data from twelve established water sampling stations located on the Blackfoot River between the

headwaters and the confluence with Landers Fork (Figure 5-1). This data set was selected based on the availability of recent sampling data (ranging from 1991 through 2001), the spatial coverage provided along the Blackfoot River and in relation to major tributaries, and the availability of the required data (total recoverable metals, dissolved aluminum, and water hardness) for comparison with water quality standards. The majority of data was collected either by Hydrometrics for the UBMC mine reclamation program, MDEQ for various project-related needs, or the USGS. In a number of cases, water quality data has been collected from the same (or similar) location by one or more entities resulting in multiple site designations for individual sampling sites (e.g., UBMC site BRSW-18 corresponds with MDEQ site CO3BKFTR02, Figure 5-1).

Water quality data for the selected sites is available for dates ranging from the late 1980s through the present. However, for the upstream segment of the Blackfoot River (above Pass Creek), only data collected after 1995 is considered representative. Due to mine reclamation activities conducted in the headwaters area in the early to mid 1990s, concentrations of many metals in the river upstream of Pass Creek have decreased. Therefore, only post-1995 data have been used to evaluate impairment conditions and develop metals TMDLs in the upstream segment of the Blackfoot River. Further downstream, effects of reclamation on water quality have been less pronounced, and the available dataset consists in some cases of only pre-1996 data. Therefore, the complete dataset has been used for impairment evaluation and TMDL development for the segment of the Blackfoot River between Pass Creek and Landers Fork.

The water quality data set used in quantifying impairment conditions in the Blackfoot River includes results for 130 samples collected from the Blackfoot River between the headwaters and the confluence with the Landers Fork. Samples were collected under a variety of streamflow conditions, including high flow, low flow, and early spring runoff. A summary of this data is shown in Table 5-1 and the full water quality dataset is included in Appendix C.

**Table 5-1 Summary of Current Blackfoot River Water Quality Data.
(Headwaters to Landers Fork)**

Stream Segment*	Site Designations	Number of Samples**	Sampled By	Analyses
Headwaters	BRSW-29	14	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC
Upstream of 1 st Natural Marsh	BRSW-12 470226112224501	15 8	Hydrometrics USGS	Metals, SO ₄ , hard., flow, pH/SC Metals, SO ₄ , hard., flow, pH/SC
Downstream of 1 st Natural Marsh	BRSW-31	8	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC
Upstream of 2 nd Natural Marsh	BRSW-16	25	Hydrometrics	Metals, SO ₄ , hard., flow, pH/SC
Near Hwy 279 Crossing	BRSW-17 CO3BKFTR01	10 1	Hydrometrics MDEQ	Metals, SO ₄ , hard., flow, pH/SC Metals, SO ₄ , hard., flow, pH/SC
Upstream of Hogum Creek	SP-SW-1.B SW-1.B 12334650	36 7 8	MDEQ Hydrometrics USGS	Metals, SO ₄ , hard., flow, pH/SC Metals, SO ₄ , hard., flow, pH/SC Metals, SO ₄ , hard., flow, pH/SC
At Aspen Grove Campground	BRSW-18 CO3BKFTR02	11 1	Hydrometrics MDEQ	Metals, SO ₄ , hard., flow, pH/SC Metals, SO ₄ , hard., flow, pH/SC

*See Figure 5-1 for sample locations.

**Samples collected 1996-2001 for sites BRSW-29, BRSW-12, 470226112224501.

hard. – hardness as CaCO₃; SO₄ – sulfate; SC – specific conductance

5.2 Impairment Conditions for the Blackfoot River Upstream of Landers Fork

Impairment conditions were evaluated for the two distinct segments of this part of the Blackfoot River: from the confluence of Anaconda and Beartrap Creeks downstream to Pass Creek, and from Pass Creek downstream to the confluence with Landers Fork (Figure 5-1).

5.2.1 Water Quality Data

Similar to Beartrap Creek (Section 4.0), water quality data for the Blackfoot River above Pass Creek show significant variability, with water quality data collected during early spring runoff exhibiting the greatest concentrations. Therefore, impairment conditions upstream of Pass Creek were quantified for three distinct streamflow conditions: high flow, low flow and early spring runoff. For the stream segment from Pass Creek downstream to Landers Fork, where distinct water quality trends during early runoff conditions are not significant, the evaluation of impairment conditions was restricted to high flow and low flow conditions only. Water quality data collected primarily in May and June (spring runoff period) were used to represent high flow water quality conditions, while data collected between August and March represent low flow conditions. For the upstream river segment, April sampling data was used to represent early spring runoff conditions.

Table 5-2 provides a comparison of current water quality data from the segment of the Blackfoot River upstream of Pass Creek to applicable water quality standards for three flow conditions. Sample sites included in this comparison are BRSW-29, BRSW-12, and 470226112224501 (Figure 5-1). Table 5-3 provides a comparison of current water quality data from the Blackfoot River between Pass Creek and Landers Fork to applicable water quality standards for high flow and low flow. Water quality data from all nine sites shown on Figure 5-1 downstream of Pass Creek were used in this comparison. The water quality data are compared to the Montana human health, chronic aquatic life, and acute aquatic life numeric criteria, and domestic use standards (for iron and manganese) for B-1 classification waters. Although temporary water quality standards were adopted and are currently in effect in the Blackfoot River upstream of Pass Creek, B-1 classification standards are utilized for evaluating impairment conditions since these standards are scheduled to take effect once again when the temporary standards expire in 2008.

The evaluation results for the Blackfoot River upstream of Pass Creek show that applicable B-1 standards are consistently exceeded for the metals cadmium, manganese, and zinc under high flow, low flow, and early runoff conditions (Table 5-2). For lead, copper, and iron water quality standards are exceeded under high flow and early runoff conditions only (Table 5-2). For the segment of Blackfoot River between Pass Creek and Landers Fork, B-1 classification standards are either consistently or occasionally exceeded for aluminum, cadmium, copper, iron, lead, manganese, and zinc, depending on the particular location (Table 5-3). Typically, concentrations of these metals are greatest and consistently exceed water quality standards in the upper portion of this stream segment near monitoring sites BRSW-31 and BRSW-16 (Figure 5-1) whereas metals concentrations exceed standards only occasionally in the middle stream reach from monitoring sites BRSW-17 to SP-SW-1.B. At monitoring site BRSW-18 above the confluence

Table 5-2 Seasonal Metals Impairment Summary for Blackfoot River Upstream of Pass Creek.

Metal	Season	n	Concentration Range (µg/L)	EXCEEDENCE SUMMARY	Water Quality Standards References
Cadmium	High Flow	12	1 to 11	<ul style="list-style-type: none"> Consistently exceeds 0.2 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	11	2 to 6	<ul style="list-style-type: none"> Consistently exceeds 0.4 µg/L chronic aquatic life criteria 	
	Early Runoff	4	6 to 16.6	<ul style="list-style-type: none"> Consistently exceeds 0.3 µg/L chronic aquatic life criteria 	
Copper	High Flow	12	5 to 170	<ul style="list-style-type: none"> Usually exceeds 7.3 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	11	4 to 10	<ul style="list-style-type: none"> Consistently less than 13.2 µg/L chronic aquatic life criteria 	
	Early Runoff	4	22 to 222	<ul style="list-style-type: none"> Consistently exceeds 11.3 µg/L chronic aquatic life criteria 	
Iron	High Flow	12	<30 to 800	<ul style="list-style-type: none"> 1 exceedence of 300 µg/L domestic use 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d) 17.30.637(1)(a)
	Low Flow	11	39 to 82	<ul style="list-style-type: none"> Consistently less than 300 µg/L domestic use 	
	Early Runoff	4	260 to 1100	<ul style="list-style-type: none"> 3 exceedences of 300 µg/L domestic use 1 exceedence of 1000 µg/L chronic aquatic life criteria 	
Lead	High Flow	12	4 to 13	<ul style="list-style-type: none"> Consistently exceeds 2.2 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	11	<3 to 3	<ul style="list-style-type: none"> Consistently less than 5.3 µg/L chronic aquatic life criteria 	
	Early Runoff	4	8 to 46	<ul style="list-style-type: none"> Consistently exceeds 4.2 µg/L chronic aquatic life criteria 	
Manganese	High Flow	12	62 to 1600	<ul style="list-style-type: none"> Consistently exceeds 50 µg/L domestic use 	17.30.623(2)(h)(i) - WQB-7
	Low Flow	11	100 to 770	<ul style="list-style-type: none"> Consistently exceeds 50 µg/L domestic use 	
	Early Runoff	4	420 to 1300	<ul style="list-style-type: none"> Consistently exceeds 50 µg/L domestic use 	
Zinc	High Flow	12	260 to 3600	<ul style="list-style-type: none"> Consistently exceeds 94 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	11	570 to 2400	<ul style="list-style-type: none"> Consistently exceeds 169 µg/L chronic aquatic life criteria 	
	Early Runoff	4	1500 to 3460	<ul style="list-style-type: none"> Consistently exceeds 145 µg/L chronic aquatic life criteria 	

Evaluation applies to Blackfoot River from confluence of Anaconda and Beartrap Creeks to confluence with Pass Creek (Figure 5-1).

Includes high flow, low flow and early runoff water quality data from 1996 through 2001.

Evaluation of exceedences based on total recoverable fraction (except for aluminum which is based on dissolved fraction).

n- number of measurements

*-aquatic criteria based on actual hardness of water sample.

Table 5-3 Blackfoot River Seasonal Metals Impairment Summary for Downstream River Segment Between Pass Creek and Landers Fork.

Metal	Season	N	Concentration Range (µg/L)	Segment Reach*	EXCEEDENCE SUMMARY	Water Quality Standards References
Aluminum	High Flow	31	<50 to 260	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> 2 exceedences of 87 µg/L chronic aquatic life criteria 2 exceedences of 87 µg/L chronic aquatic life criteria Consistently lower than 87 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i)-WQB-7 17.30.637(1)(d)
	Low Flow	37	<50 to 300	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Consistently lower than 87 µg/L chronic aquatic life criteria Consistently lower than 87 µg/L chronic aquatic life criteria Consistently lower than 87 µg/L chronic aquatic life criteria 	
Cadmium	High Flow	29	<0.1 to 2.4	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Consistently exceeds 0.2 µg/L chronic aquatic life criteria 2 exceedences of 0.3 µg/L chronic aquatic life criteria Consistently lower than 0.3 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	46	<0.1 to 2	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Consistently exceeds 0.3 µg/L chronic aquatic life criteria 1 exceedence of 0.3 µg/L chronic aquatic life criteria Consistently lower than 0.3 µg/L chronic aquatic life criteria 	
Copper	High Flow	29	<1 to 18	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Consistently exceeds 7.3 µg/L chronic aquatic life criteria 1 exceedence of 8.5 µg/L chronic aquatic life criteria Consistently lower than 8.5 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	46	<1 to 19	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Occasionally exceeds 11.3 µg/L chronic aquatic life criteria Consistently lower than 10.1 µg/L chronic aquatic life criteria Consistently lower than 10.1 µg/L chronic aquatic life criteria 	
Iron	High Flow	29	80 to 1680	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Occasionally exceeds 300 µg/L domestic use 1 exceedences of 300 µg/L domestic use; 1 exceedence of 1000 µg/L chronic aquatic life criteria 1 exceedence of 300 µg/L domestic use 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d) 17.30.637(1)(a)

Table 5-3 Blackfoot River Seasonal Metals Impairment Summary for Downstream River Segment Between Pass Creek and Landers Fork.

Metal	Season	N	Concentration Range (µg/L)	Segment Reach*	EXCEEDENCE SUMMARY	Water Quality Standards References
	Low Flow	46	<30 to 880	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Consistently exceeds 300 µg/L domestic use at BRSW-31; and occasionally exceeds this value at BRSW-16 1 exceedence of 300 µg/L domestic use Consistently lower than 300 µg/L domestic use 	
Lead	High Flow	29	<2 to <10	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Occasionally exceeds 2.2 µg/L chronic aquatic life criteria 1 exceedence of 2.8 µg/L chronic aquatic life criteria Consistently lower than 2.8 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	46	<2 to <10	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> 1 exceedence of 4.2 µg/L chronic aquatic life criteria Consistently lower than 3.6 µg/L chronic aquatic life criteria Consistently lower than 3.6 µg/L chronic aquatic life criteria 	
Manganese	High Flow	26	8 to 220	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Consistently exceeds 50 µg/L domestic use 2 exceedences of 50 µg/L domestic use Consistently lower than 50 µg/L domestic use 	17.30.623(2)(h)(i) - WQB-7
	Low Flow	36	<5 to 340	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Consistently exceeds 50 µg/L domestic use 2 exceedences of 50 µg/L domestic use Consistently lower than 50 µg/L domestic use 	
Zinc	High Flow	29	<10 to 760	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Consistently exceeds 94 µg/L chronic aquatic life criteria 4 exceedences of 110 µg/L chronic aquatic life criteria Consistently less than 110 µg/L chronic aquatic life criteria 	17.30.623(2)(h)(i) - WQB-7 17.30.637(1)(d)
	Low Flow	46	<10 to 880	UPSTREAM MIDDLE DOWNSTREAM	<ul style="list-style-type: none"> Consistently exceeds 145 µg/L chronic aquatic life criteria 2 exceedences of 130 µg/L chronic aquatic life criteria Consistently less than 110 µg/L chronic aquatic life criteria 	

Evaluation applies to Blackfoot River from confluence with Pass Creek to confluence with Landers Fork (Figure 5-1).

Includes high flow and low water quality data from 1991 through 2001; n- number of measurements.

Evaluation of exceedences based on total recoverable fraction (except for aluminum which is based on dissolved fraction); aquatic criteria based on actual hardness of water sample.

*UPSTREAM = sites BRSW-31, BERSW-16; MIDDLE = sites BRSW-17, C03BKFT01, SP-SW-1.B; DOWNSTREAM = sites BRSW-18, C03BKFT02

with the Landers Fork, only one potential exceedence of water quality standards (an iron concentration of 400 µg/L on 4/26/99) was recorded in 12 samples collected between 1991 and 2001 (Appendix C). Table 5-4 shows the percentage of total measurements exceeding applicable water quality standards under various flow conditions in the upstream and downstream segments of the Blackfoot River headwaters.

Table 5-4 Percentage of Water Quality Measurements Exceeding Applicable Standards on a Seasonal Basis.

<u>Parameter</u>	<u>Blackfoot River Upstream of Pass Creek</u>			<u>Blackfoot River Between Pass Creek and Landers Fork</u>	
	<u>High Flow</u>	<u>Low Flow</u>	<u>Early Runoff</u>	<u>High Flow</u>	<u>Low Flow</u>
Cd	100%	100%	100%	52%	28%
Cu	92%	0%	100%	31%	11%
Fe	0%	0%	75%	24%	15%
Pb	100%	0%	100%	17%	4%
Mn	100%	100%	100%	35%	39%
Zn	100%	100%	100%	52%	33%

Applicable water quality standards include human health/domestic use, aquatic acute and aquatic chronic criteria. Domestic use standard refers to guidance level included in WQB-7 for iron and manganese in surface water per ARM 17.30.601.

5.2.2 Streambed Sediment Metals Concentrations

Two stream sediment samples were collected from the Blackfoot River upstream of Pass Creek as part of the UBMC mine reclamation program (PTI, 1993). The samples were collected from the 0 to 2-inch depth interval but the sediment size fraction sampled is not specified in the report. The sampling locations (designated MH-19 and MH-20) are immediately downstream of the confluence of Beartrap and Anaconda Creeks (corresponding approximately to surface water sampling site BRSW-29), and about 1000 feet further downstream, respectively. The samples were analyzed for total metals concentrations, with the analytical results shown in Table 5-5.

Several investigations have documented stream sediment metals concentrations in the Blackfoot River between Pass Creek and Landers Fork (Moore, 1990; Menges, 1997; Nagorski et al., 2000). Results from two of the more recent samples (1998) are included in Table 5-5. The location above Hogum Creek represents the lower portion of this stream segment, and the location above Meadow Creek represents the upper portion of this stream segment in the vicinity of the Upper Marsh (Figure 5-1).

Results from these sediment samples indicate the channel sediments contain elevated concentrations of a number of metals, including arsenic, cadmium, copper, iron, manganese, lead, and zinc. These values significantly exceed typical guidance values presented in the literature for assessing toxicity concerns for aquatic biota from streambed sediments (Jones et al., 1997; Long and Morgan, 1990), particularly at the three upstream locations. The lowest sampling location (above Hogum Creek) shows a significant decrease in overall metals concentrations of concern, with zinc being the metal that appears to be elevated above probable background conditions more than any other metal. Based on this data, it is concluded that streambed sediment metals concentrations are likely contributing to impairment of the Blackfoot

River from the headwaters downstream to the confluence with Landers Fork, particularly in the upstream portions.

Table 5-5 Blackfoot River Stream Sediment Metals Concentrations.

Parameter	Upstream of Pass Creek ¹		Downstream of Pass Creek ²	
	Site MH-19 Mg/Kg	Site MH-20 Mg/Kg	BFR above Meadow Ck Mg/Kg	BFR above Hogum Ck Mg/Kg
Aluminum	9050	10638	18856	6307
Silver	13	4.8	Na	Na
Arsenic	181	67	84	17
Cadmium	22	11	32	3
Cobalt	26	15	Na	Na
Chromium	12	12	9	10
Copper	552	344	1414	81
Iron	67750	33525	66863	21557
Manganese	3030	2122	4610	1270
Nickel	24	17	Na	Na
Lead	1879	1238	1263	43
Zinc	4113	2540	5723	959

¹ Sampling results from PTI, 1993.

² Sampling results from Nagorski et al., 2000.

5.2.3 Impairment Determination for the Blackfoot River

The water quality and sediment chemistry data summarized above, along with the biological data presented in the Phase I report (Confluence et al., 2002), and summarized in Section 1.3.1, justify the metals impairment determination and TMDL development for the Blackfoot River upstream of Landers Fork.

5.3 Source Characterization for the Blackfoot River Upstream of Landers Fork

5.3.1 Metals Source Inventory

Sources of metals loading to the Blackfoot River upstream of Landers Fork are primarily related to historic mining activities. The majority of mining activity within the drainage occurred at the UBMC, although numerous other mines, most of them small in size and production history, are located in the portion of the drainage downstream of the UBMC (Figure 5-1). Other possible sources of metals loading to the river include roads and natural background sources.

Documented sources of metals loading are described below. As in previous discussions, the source assessment includes separate discussions on the Blackfoot River upstream of Pass Creek and downstream of Pass Creek to Landers Fork.

5.3.1.1 Sources Upstream of Pass Creek

Known sources of metals loading to the segment of river upstream of Pass Creek in upstream to downstream order include: surface water inflow from Beartrap Creek; discharge of treated mine drainage from the constructed wetlands-based water treatment system operated by Asarco and regulated under the Montana Pollutant Discharge Elimination System (MPDES) program; surface water inflow from Stevens Gulch; an area of concentrated mine tailings on the Blackfoot River floodplain near the confluence with Shave Gulch; dispersed tailings located along the floodplain, and surface water inflow from Paymaster Creek (Figure 5-1 and 5-2).

5.3.1.2 Sources Downstream of Pass Creek

Metals loading sources to the Blackfoot River are not as well documented downstream of Pass Creek as are upstream sources. However, the available water quality data does identify a number of potential metals loading sources, and certain metals loading source areas where metals loads increase but specific sources cannot be identified. In addition to the loading from sources upstream of Pass Creek, identified metals loading sources or source areas to the Blackfoot River in this downstream segment include, but may not be limited to: the upper and lower marsh complex (Figure 5-1) where loads of certain metals in the river increase; and loads associated with surface water inflow from tributary drainages (e.g. Hogum Creek, Hardscrabble Creek, Alice Creek) (Figure 5-1).

5.3.2 Metals Source Analysis

5.3.2.1 Source Upstream of Pass Creek

Metals loading sources within the UBMC have been well characterized through synoptic surface water sampling and streamflow monitoring completed under Asarco's mine reclamation program (Hydrometrics, 2000a, 2001, 2002). Figure 5-3 depicts downstream seasonal loading trends (April, May, June, and October 2001) for the metals cadmium, copper, iron, lead, manganese and zinc from monitoring site BRSW-29, located at the confluence of Anaconda and Beartrap Creeks, to monitoring site BRSW-12, located near the UBMC Implementation Plan boundaries (Figure 5-2). Data for monitoring site BRSW-32, located between BRSW-29 and BRSW-12 downstream of a concentrated tailings deposit near the confluence with Shave Gulch, is also included on Figure 5-3 to provide additional detail on loading trends in the river relative to potential sources.

Historical data has shown that metal loads at site BRSW-29, the furthest upstream site on the Blackfoot River, are derived almost exclusively from Beartrap Creek, with no significant contribution from Anaconda Creek (Hydrometrics, 2002; see also Figure 4-2 and Figure 5-3). In 2001, for example, calculated cadmium loads at the furthest downstream Beartrap Creek site (BRSW-38) were 0.27 lb/day in April, 0.19 lb/day in May, 0.20 lb/day in June, and 0.006 lb/day in October. At site BRSW-29, cadmium loads were 0.20 lb/day in April, 0.24 lb/day in May, 0.20 lb/day in June, and 0.01 lb/day in October.

The combined contributions of metals loading sources on the Blackfoot River downstream of site BRSW-29 to site BRSW-12 for the year 2001 are evident in Figure 5-3. As noted previously, these sources include discharge of treated mine drainage from the constructed wetlands-based water treatment system; surface water inflow from Stevens Gulch; concentrated mine tailings along the Blackfoot River floodplain near the confluence with Shave Gulch; and dispersed tailings located along the floodplain. Paymaster Creek enters the Blackfoot River through the marsh system downstream of BRSW-12. Therefore, metals loading from this source is not depicted on Figure 5-3.

Figure 5-3 shows that seasonal metal loads in the river increase from BRSW-29 to BRSW-12 during high flow periods (May and June) with nearly all of the increase occurring between BRSW-29 and BRSW-32. During low flow (October), loads increase from BRSW-29 to BRSW-32, then decrease further downstream due primarily to a decrease in flow between BRSW-32 and BRSW-12. During the early runoff period (April), the metals load at site BRSW-29 is typically greater than or equal to the load at downstream site BRSW-12 (Figure 5-3), suggesting that during the early runoff period, the metals load contribution from Beartrap Creek drainage dominates the total load in the portion of the Blackfoot River upstream of Pass Creek. The downstream decrease in the load of certain metals observed during April (copper, iron, manganese, lead) presumably is due to precipitation of metals from the water column to the streambed.

Metal loading from the known specific sources in this portion of the Blackfoot River is summarized below.

- Constructed Wetlands Discharge – Loading from the wetlands discharge was calculated for May and October 2001, and compared with the instream loads for May and October 2001 at monitoring site BRSW-34, located on the Blackfoot River immediately downstream of the discharge (Figure 5-2). Wetland discharge metal loads were 3.5 lb/day iron, 22 lb/day manganese, and 53 lb/day zinc in May, and 0.013 lb/day cadmium, 0.03 lb/day copper, 1.3 lb/day manganese, and 9.0 lb/day zinc in October (loads were not calculated for metals reported as below detection limits in the wetland discharge). These loads correlate to the following percentages of instream metal loads: 0.7% iron, 0.3% manganese, and 0.5% zinc in May, and 15.2% cadmium, 15.2% copper, 36.5% manganese, and 100% zinc in October (Hydrometrics, 2002). Based on this information, the treatment system discharge represents a significant source of metals loading to the Blackfoot River and will require further reductions, particularly for low flow periods.
- Stevens Gulch – Surface water from Stevens Gulch contains elevated concentrations of some metals, and thus represents a potential loading source to the Blackfoot River. Metal loads at lower Stevens Gulch site BRSW-8 were calculated for May and October 2001, and compared with the instream loads for May and October 2001 at monitoring site BRSW-9, located on the Blackfoot River immediately downstream of the confluence of Stevens Gulch with the river. Stevens Gulch loads at BRSW-8 were 0.002 lb/day cadmium, 0.16 lb/day copper, 0.19 lb/day iron, 0.45 lb/day manganese, 0.01 lb/day lead, and 0.33 lb/day zinc in May, and 0.00004 lb/day cadmium, 0.0006 lb/day copper, 0.00007 lb/day iron, 0.002 lb/day manganese, 0.00001 lb/day lead, and 0.001 lb/day zinc

in October. These loads accounted for the following percentage of instream metals loads during May and October, respectively: cadmium, 0.6% and 0.03%; copper, 10% and 3 %; iron, 6% and 0.06 %, manganese, 2.4% and 0.2%; lead, 1.5% and 0.2%; and zinc, 0.6% and 0.02%.

- Concentrated Tailings/Dispersed Tailings/Remaining Sources – Additional known sources of metal loading to the Blackfoot River upstream of Pass Creek include an area of concentrated tailings near the confluence with Shave Gulch (Figure 5-2); dispersed tailings located along the Blackfoot River floodplain; and possible additional sources currently unidentified such as additional mining sources or recharge from mineralized groundwater. Water quality data collected along the Blackfoot River has shown consistent loading increases through this area. For example, metal load increases measured in May 2001 from site BRSW-9 to site BRSW-12, where the river traverses the area of concentrated and dispersed tailings, were 0.2 lb/day for cadmium, 0.8 lb/day for copper, 3.6 lb/day for iron, 0.2 lb/day for lead, 10 lb/day for manganese, and 46 lb/day for zinc. Consistent metal load increases were also observed in this reach during June 2001, and during October 2001 for all metals except manganese and zinc. These load increases can be attributed to the concentrated or dispersed tailings as well as any remaining sources not yet identified.
- Paymaster Creek – Paymaster Creek enters the Blackfoot River opposite Pass Creek and downstream of monitoring site BRSW-12 (Figure 5-2). Water quality data confirms that the surface waters in the drainage contain elevated concentrations of some metals, including aluminum, copper, iron and manganese (Hydrometrics, 2000). Asarco and ARCO reclaimed the historic Paymaster Mine, part of the UBMC, in 1996, although only portions of the Paymaster Voluntary Cleanup Plan were approved by MDEQ since other issues associated with this source such as groundwater and its impacts on Paymaster Creek remain unresolved.

Since Paymaster Creek enters the Blackfoot River as dispersed flow through the marsh complex, direct measurement of metals loading to the Blackfoot River is not possible. However, water quality data collected from lower Paymaster Creek (monitoring site BRSW-13) show that during May 1999 the creek carried 0.7 lb/day copper, 71 lb/day iron, 0.1 lb/day lead, 1.1 lb/day manganese, and 0.5 lb/day zinc to the Blackfoot River marsh system; during October 1999, load contributions were 0.03 lb/day copper, 1.3 lb/day iron, 0.0007 lb/day lead, 0.08 lb/day manganese, and 0.02 lb/day zinc (cadmium concentrations were below detection limits). Historical data for Paymaster Creek has also shown that water quality exceedences in the creek are present both upstream and downstream of historic mining activity. For example, in October 1998, the iron concentration at BRSW-13 (downstream of the Paymaster Mine) was 4900 µg/L, while at BRSW-21 (upstream of the mine) the concentration was 4800 µg/L. Similarly, the manganese concentration was 340 µg/L downstream and 290 µg/L upstream. Investigations of the Paymaster Mine area have suggested that, in addition to possible remaining impacts from past mining activities, metals concentrations may be naturally elevated in portions of the drainage (Furniss, 1998).

5.3.2.2 Source Analysis Downstream of the Pass Creek

Figure 5-4 depicts downstream seasonal loading trends for cadmium, copper, iron, lead, manganese, and zinc from the downstream end of the UBMC Implementation Plan boundary (monitoring site BRSW-12) to immediately upstream of the confluence with the Landers Fork (monitoring site BRSW-18, Figure 5-1). Loading trends are shown for recent representative low flow (October 1998) and high flow (April 1999) events.

The dominant sources of metals loading to the Blackfoot River downstream of Pass Creek are the UBMC sources upstream of Pass Creek. Therefore, UBMC reclamation responsibilities may extend downstream of Pass Creek under the Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA), which is further discussed in Section 6.2.1. As shown in Figure 5-4, the April 1999 metal loads exiting the UBMC (site BRSW-12) are greater than downstream loads for all metals except iron. Based on data from site BRSW-12 collected from 1996 through 2001, the average Blackfoot River metal load exiting the UBMC area under high flow conditions was 0.6 lb/day cadmium, 4.1 lb/day copper, 22 lb/day iron, 41 lb/day manganese, 2 lb/day lead, and 132 lb/day zinc. Over the same period, the average load under low flow conditions was 0.04 lb/day cadmium, 0.06 lb/day copper, 0.4 lb/day iron, 2.7 lb/day manganese, 0.02 lb/day lead, and 11 lb/day zinc. Metals loading from the UBMC is being addressed under the temporary standards Implementation Plan currently in effect for the section of the Blackfoot River upstream of Pass Creek (see Section 4.4 and 5.4). Completion of activities outlined in the Implementation Plan is intended to result in compliance with B-1 water quality standards at the downstream margin of the UBMC as defined by the Implementation Plan (Hydrometrics, 2000).

Immediately downstream of the UBMC Implementation Plan boundary, metal loading trends vary on a seasonal basis. With the exception of iron, metal loads consistently decreased through the upper marsh system (between sites BRSW-12 and BRSW-31) in April 1999 indicating metals were being removed from the water column through chemical precipitation and/or adsorption processes. Conversely, loads of several metals, including copper, iron and manganese, increased through the marsh in October 1998 (Figure 5-4). Comparison of data collected at sites BRSW-12 and BRSW-31 from 1998 through 2001 shows the following metals loading trends through the marsh system:

- Iron loads increase through the marsh during both high and low flow conditions. At high flow, the average increase is 216% or 18.2 lb/day, and during low flow, the average increase is 2743%, or 9.2 lb/day.
- Copper and manganese loads increase through the marsh under low flow conditions, but decrease under high flow conditions. Average increases during low flow for these parameters are 0.2 lb/day or 371% for copper, and 3.3 lb/day or 433% for manganese.
- Zinc, lead and cadmium loads typically decrease or remain unchanged through the marsh under both high and low flow conditions.

Loading trends through the marsh may be related to a number of mechanisms, including the presence of historically deposited mine tailings within the marsh, tributary inflows, recharge from mineralized groundwater, and removal of metals from the water column through chemical

precipitation and/or adsorption. It is also possible that seasonally precipitated/ adsorbed metals may be released back to the water column during other times of the year, thus acting as a seasonal loading source. Such mechanisms could explain the seasonal loading trends noted for copper through the marsh. If so, future improvements in Blackfoot River water quality, anticipated in response to the UBMC mine reclamation program, should reduce and may eliminate certain seasonal metals load increases currently attributed to the upper marsh.

Metal loads vary significantly downstream of the upper marsh complex to the confluence with Landers Fork (Figure 5-4). Of particular interest are the significant load increases for copper, iron and manganese recorded between sites BRSW-17 and BRSW-18. During April 1999, loads across this reach increased by 4.2 lb/day for copper, 480 lb/day for iron, and 16 lb/day for manganese. Low flow sampling in October 1998 showed load increases of 0.3 lb/day for copper and 3.6 lb/day for iron. Possible sources for these load increases include tributary inflows, possible metals-bearing sediments within the lower marsh complex located between these two sites, and/or recharge from mineralized groundwater. Major tributaries within this stream reach include Willow Creek, Alice Creek, Hardscrabble Creek, and Hogum Creek (Figure 5-1). Available water quality data indicate that some of these tributaries contain detectable concentrations of metals, with concentrations of some metals periodically exceeding the numeric water quality criteria. Section 6.3 outlines a monitoring program designed to better delineate the source(s) of metal load increases to this portion of the Blackfoot River. It is important to note, however, that despite the significant increases in loads of certain metals noted in Figure 5-4 at BRSW-18, metals concentrations at this site meet applicable water quality standards. This means that efforts to address these metal load increases may not be critical to restoration plan development for the Blackfoot River, although such efforts could be critical to ensure full support of beneficial uses in one or more of the tributaries along this river segment.

5.4 Restoration Targets, TMDLs and Load Allocations for the Blackfoot River Upstream of Landers Fork

Water quality restoration targets and TMDLs are established below based on applicable water quality standards and documented streamflow rates in the Blackfoot River. Due to the significant differences in physical and chemical characteristics of the Blackfoot River upstream and downstream of Pass Creek, water quality restoration targets and metals TMDLs are developed separately for these two river segments. The two river segments are also addressed separately in defining load allocations due to the applicability of UBMC Temporary Standards Implementation Plan to the segment of river upstream of Pass Creek only, and the differing levels of relevant information available from the two stream segments.

5.4.1 Metals Restoration Targets

Water quality restoration targets for metals in the Blackfoot River upstream of Pass Creek and downstream of Pass Creek are listed in Table 5-6. For the stream segment above Pass Creek, restoration targets are presented based on water hardness data from monitoring site BRSW-12. For the stream segment between Pass Creek and Landers Fork, restoration targets are presented for two sites, BRSW-31 in the upper portion of this stream segment, and SP-SW-1.B in the lower portion (Figure 5-1), due to varying water chemistry and hardness conditions through this

segment. For both stream segments, restoration targets are established for the metals cadmium, copper, iron, lead, manganese and zinc since extensive testing has indicated that these metals exceed applicable water quality standards on a regular basis. Due to the anticipated common sources of elevated metals concentrations in the drainage (historic mining), it is assumed that restoration activities focusing on these metals will also address any other metals that may exceed applicable water quality standards.

Restoration targets are established for three distinct streamflow conditions for the stream segment above Pass Creek (monitoring location BRSW-12). These include high flow (near peak), low flow (at or near baseflow conditions), and early runoff conditions (rising limb of the hydrograph). Similar to conditions within Beartrap Creek drainage (Section 4), metals concentrations in this portion of the river generally are greatest during early runoff (generally in April) conditions (see water quality data, Appendix C). For the stream segment between Pass Creek and Landers Fork (monitoring locations BRSW-31 and SP-SW-1.B), restoration targets are developed for high (near peak) and low flow (at or near baseflow) conditions only since early spring runoff water quality does not differ significantly from that of other flow periods.

The restoration targets for cadmium, copper, lead and zinc are based on the applicable numeric water quality standards associated with chronic aquatic life criteria, with appropriate hardness modifications. Basing restoration targets on the chronic aquatic criteria will ensure that other numeric criteria (human health, acute aquatic life) are met since the chronic criteria are the most stringent (lowest concentration). The restoration targets for iron and manganese are based on the 300 µg/L and 50 µg/L guidance values for drinking water use support in WQB-7 (MDEQ, 2001b). Iron also has an upper limit target of 1000 µg/L based on the chronic criteria for aquatic life support.

Hardness values used in calculating the targets are based on actual measured values as specified in Table 5-6. Because it is unknown what the actual hardness value will be under restoration conditions, the target values listed in Table 5-6 for these metals represent estimated values at the various flow conditions. The actual targets will be based on in-stream hardness values as measured at the time of sampling. Appendix A provides an example of the hardness adjustment equation for chronic aquatic life support standards.

Compliance with the water quality targets will require that the concentration of each individual metal not exceed the applicable water quality standards in more than 10% of the water samples. This approach is consistent with MDEQ guidance for making beneficial use support determinations (MDEQ, 2002). In evaluating compliance with the iron and manganese drinking water use targets, consideration should be given to the level and frequency of exceedences, and whether or not the exceedences interfere with the uses specified in the surface water quality standards (ARM 16.30.623). Appendix A provides additional discussion for evaluating compliance with the iron and manganese targets.

In addition to the water chemistry-based targets, iron has an additional target of no visible streambed deposits of iron precipitates resulting from human caused conditions. Another target is that metals concentrations in sediments cannot impede beneficial uses, with focus on aquatic life support. This target applies to all metals, either individually or in combination, which may

occur at potentially toxic concentrations in stream sediments. A number of metals are of concern, especially further upstream, given the relatively high levels in sediment chemistry as identified in Table 5-5. Assessment of stream sediment concentrations and beneficial use support conditions will be consistent with the stream sediment screening approach discussed in Section 1.2.3.

Consistent with the Sandbar Creek, Poorman Creek, and Beartrap Creek restoration targets, an additional restoration target for macroinvertebrate and periphyton communities also applies. Metals concentrations must not impede attainment of full support conditions for these communities when compared to a known reference condition using standard MDEQ protocols (reference Appendix A). The monitoring locations for compliance with the sediment chemistry and biota targets will be the same as discussed above for water chemistry sampling, although it should be noted that such sampling typically occurs once at each location during low flow conditions.

It is important to note that the above targets represent minimum requirements for protecting beneficial uses identified within Montana's Surface Water Quality Standards, and are based on interpretations of available data presented within this plan. Other regulatory programs with water quality protection responsibilities may impose additional requirements to ensure full compliance with all appropriate local, State and Federal laws.

5.4.2 Blackfoot River Metals TMDL

Similar to the metals TMDLs developed for other Planning Area water bodies, the Blackfoot River metals TMDLs are based on a loading equation designed to ensure compliance with water quality standards under any streamflow rates and potential restoration targets. Equation 5-1 defines the metals TMDLs for the Blackfoot River.

Equation 5-1: *Total Maximum Daily Load (lb/day) = (X ug/l)(Y cfs)(0.0054)*

where:

X = the applicable water quality numeric standard (target) in ug/l with hardness adjustments where applicable (see above discussion on targets);

Y = streamflow in cubic feet per second;

(0.0054) = conversion factor

Tables 5-7 and 5-8 provide metals TMDLs calculated for specific high flow, low flow, and early runoff conditions in the Blackfoot River above Pass Creek, and high flow and low flow conditions below Pass Creek, respectively. Upstream of Pass Creek, the TMDLs were developed for site BRSW-12. Downstream of Pass Creek, TMDLs were developed for two locations; BRSW-31 at the downstream end of the upper marsh, and site SP-SW-1.B near the confluence with Landers Fork (Figure 5-1). The TMDLs were calculated using Equation 5-1, and the seasonal water quality restoration targets presented in Table 5-6 and corresponding streamflow rates measured at each site. For streamflow rates, the average of all available flow measurements from a particular site for the specified season were used. For example, the low flow TMDL for site BRSW-12 is based on the average of seven streamflow measurements (1.4 cfs) taken in October at BRSW-12. The streamflow rates used in calculating the seasonal TMDLs are specified in Tables 5-7 and 5-8.

Table 5-6 Water Quality Restoration Targets for Metals in the Blackfoot River Upstream and Downstream of Pass Creek.

Pollutant	Restoration Targets Upstream of Pass Creek	Restoration Targets From Pass Creek to Landers Fork		Limiting Beneficial Use
	Site BRSW-12	Site BRSW-31	Site SP-SW-1.B	
Cadmium	0.4 ug/l (low flow) 0.2 ug/l (high flow) 0.3 ug/l (early runoff)	0.3 ug/l (low flow) 0.2 ug/l (high flow)	0.3 ug/l (low flow) 0.3 ug/l (high flow)	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life (chronic)
Copper ¹	13.2 ug/l (low flow) 7.3 ug/l (high flow) 11.3 ug/l (early runoff)	11.3 ug/l (low flow) 7.3 ug/l (high flow)	10.1 ug/l (low flow) 8.5 ug/l (high flow)	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life (chronic)
Iron	300 ug/l 1000 ug/l (all flows) No visible stream bed deposits associated with controllable human sources	300 ug/l 1000 ug/l (all flows) No visible stream bed deposits associated w/ controllable human sources	300 ug/l 1000 ug/l (all flows)	Drinking water (domestic use) Aquatic life (chronic) Aquatic life
Lead	5.3 ug/l (low flow) 2.2 ug/l (high flow) 4.2 ug/l (early runoff)	4.2 ug/l (low flow) 2.2 ug/l (high flow)	3.6 ug/l (low flow) 2.8 ug/l (high flow)	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life (chronic)
Manganese	50 ug/L	50 ug/L	50 ug/L	Drinking water (domestic use)
Zinc	169 ug/l (low flow) 94 ug/l (high flow) 145 ug/l (early runoff)	145 ug/l (low flow) 94 ug/l (high flow)	130 ug/l (low flow) 110 ug/l (high flow)	Aquatic Life (chronic) Aquatic Life (chronic) Aquatic Life (chronic)
Metals	No metals concentrations in sediments that may impede beneficial uses.			Aquatic Life
	Macroinvertebrate and periphyton communities must show no impairment from metals.			Aquatic Life

Notes: 1. Targets are estimated based on predicted hardness values of 75 mg/L during high flow, 150 mg/L at low flow, and 125 mg/L (as CaCO₃) at BRSW-12, 75 mg/L at low flow and 125 mg/L at high flow at BRSW-31, and 90 mg/L at high flow and 110 mg/L at low flow at SP-SW-1.B after completion of restoration activities; actual targets will be determined by hardness at time of sampling.

The TMDLs presented in the tables apply to the specified streamflow and water hardness conditions only. Equation 5-1 allows calculation of TMDLs for any specific streamflow rate and water quality restoration target. Because the TMDLs in Tables 5-7 and 5-8 are based on the average of multiple flow measurements obtained at the specified sites under the specified flow conditions, the TMDLs are believed to be representative of overall seasonal TMDL requirements.

Some additional notes concerning the Blackfoot River TMDLs and the target conditions they are intended to satisfy include:

- For iron, the TMDL based on the 300 ug/l drinking water/domestic use support condition is expected to satisfy the additional target of no visible stream bed deposits associated with iron hydroxide precipitates from human causes.
- Based on seasonal and other considerations associated with the iron and manganese drinking water/domestic use support criteria, a higher TMDL may be acceptable for both iron and manganese as long as other target criteria associated with visible stream deposits, sediment toxicity, biota support, and chronic aquatic life criteria are satisfied.

Meeting the cadmium, copper, iron, lead, manganese and zinc TMDLs is expected to satisfy the restoration targets associated with sediment toxicity (Table 5-6) for two reasons. First, restoration activities designed to address existing sources of water quality impairment should also eliminate the source(s) of elevated sediment concentrations. Secondly, as metal loads in the Blackfoot River are reduced to TMDL levels, the fine-grained metals-bearing sediments likely will flush through the system during high flow periods via typical sediment transport processes. As source areas are reclaimed through the ongoing UBMC reclamation program and downstream reclamation efforts, the displaced sediments will be replaced with fewer metals-bearing sediments. Since other metals which may occur at elevated concentrations in sediments are likely derived from the same mining-related sources as cadmium, copper, iron, lead, manganese and zinc, meeting the TMDLs for these metals are expected to address sediment toxicity issues which may exist for other metals in the Blackfoot River. The assumption that TMDL implementation will result in attainment of the sediment chemistry target will be confirmed through post-implementation sediment sampling.

- Meeting all of the metals TMDLs is expected to eliminate any metals-related impediments to satisfying the target associated with macroinvertebrate and periphyton communities being at full support conditions in comparison to reference conditions.

Tables 5-7 and 5-8 also provide estimates of the percent total load reduction required to meet the TMDLs and water quality restoration targets under the various flow conditions. These estimates are based on current metal loads calculated from seasonal streamflow and metals concentration data from monitoring site BRSW-12, BRSW-31 and SP-SW-1.B. For example, the required load reduction for meeting the TMDL for cadmium at BRSW-12 is greater than 90% during high flow, low flow and early runoff conditions (Table 5-7). Note that the required load reductions in Tables 5-7 and 5-8 are negative for certain metals under some flow conditions. This indicates that the restoration target for that particular metal is currently being met at least part of the time

Table 5-7 TMDL and Load Reduction Examples for Metals at Documented High Flow, Low Flow and Early Runoff Conditions for Blackfoot River Above Pass Creek (Site BRSW-12).

Pollutant	Target (ug/l)	Mean Low Flow (1.38 cfs) TMDL¹ (lb/day)	Mean High Flow (37.3 cfs) TMDL¹ (lb/day)	Mean Early Runoff (15.8 cfs) TMDL¹ (lb/day)	% Total Load Reduction Needed to Meet TMDLs and Targets
Cadmium	0.4 (low flow) 0.2 (high flow) 0.3 (early runoff)	0.003	0.040	0.026	92.0% (low flow) 93.4% (high flow) 95.6% (early runoff)
Copper	13.2 (low flow) 7.3 (high flow) 11.3 (early runoff)	0.10	1.46	0.96	-52% (low flow); 60.9% (high flow) 74.3% (early runoff)
Iron	300 (low flow) 300 (high flow) 300 (early runoff)	2.24	60.2	25.5	-470% (low flow); -270% (high flow) 7.7% (early runoff)
Lead	5.3 (low flow) 2.2 (high flow) 4.2 (early runoff)	0.04	0.44	0.36	-76.7% (low flow); 76.8% (high flow) 68.9% (early runoff)
Manganese	50 (low flow) 50 (high flow) 50 (early runoff)	0.37	10.03	4.25	84.3% (low flow); 77.1% (high flow) 89.6% (early runoff)
Zinc	169 (low flow) 94 (high flow) 145 (early runoff)	1.26	18.87	12.33	89.2% (low flow) 87.2% (high flow) 90.9% (early runoff)

1. Mean high flow, low flow and early runoff values based on average of seasonal flow measurements from site BRSW-12 from 1996 through 2001.

Early runoff data from April.

Negative value for % Total Load Reduction Required indicates that the restoration target is being met most or all of the time at site BRSW-12 during the specified flow conditions.

However, these metals consistently exceed restoration targets in the Blackfoot River upstream of BRSW-12.

Table 5-8 TMDL and Load Reduction Examples for Metals at Documented High Flow and Low Flow Conditions for Blackfoot River Between Pass Creek and Landers Fork (Monitoring Sites BRSW-31 and SP-SW-1.B).

	BRSW-31			SP-SW-1.B		
Pollutant	Water Quality Restoration Target (ug/l)	Mean Low Flow (2.6 cfs) and High Flow (28 cfs) TMDL¹ (lb/day)	% Total Load Reduction Required	Water Quality Restoration Target (ug/l)	Mean Low Flow (40 cfs) and High Flow (154 cfs) TMDL¹ (lb/day)	% Total Load Reduction Required
Cadmium	0.3 (low flow) 0.2 (high flow)	0.0042 (low flow) 0.03 (high flow)	77.4% (low flow) 90.2% (high flow)	0.3 (low flow) 0.3 (high flow)	0.06 (low flow) 0.25 (high flow)	-200% (low flow) -50% (high flow)
Copper	11.3 (low flow) 7.3 (high flow)	0.157 (low flow) 1.10 (high flow)	37.2% (low flow); 43.9% (high flow)	10.1 (low flow) 8.5 (high flow)	2.15 (low flow) 7.04 (high flow)	-710% (low flow); -113% (high flow)
Iron	300 (low flow) 300 (high flow)	4.16 (low flow) 45.0 (high flow)	57.0% (low flow); -34.3% (high flow)	300 (low flow) 300 (high flow)	64.0 (low flow) 248.0 (high flow)	-471% (low flow); 30.9% (high flow)
Lead	4.2 (low flow) 2.2 (high flow)	0.06 (low flow) 0.33 (high flow)	-40.0% (low flow); 26.7% (high flow)	3.6 (low flow) 2.8 (high flow)	0.77 (low flow) 2.32 (high flow)	-20.0% (low flow); 30.0% (high flow)
Manganese	50 (low flow) 50 (high flow)	0.69 (low flow) 7.50 (high flow)	83.1% (low flow); 34.5% (high flow)	50 (low flow) 50 (high flow)	10.7 (low flow) 41.4 (high flow)	-510% (low flow); 24.9% (high flow)
Zinc	145 (low flow) 94 (high flow)	2.01 (low flow) 14.2 (high flow)	77.3% (low flow) 85.0% (high flow)	130 (low flow) 110 (high flow)	27.7 (low flow) 91.1 (high flow)	-194% (low flow) -40.0% (high flow)

1-Mean high flow and low flow values based on average of seasonal flow measurements at specified sites.

Negative value for % Total Load Reduction Required indicates that the restoration target is being met most or all of the time at specified site during the specified flow conditions. However, these metals consistently exceed restoration targets in the Blackfoot River upstream of specified sampling site.

at the designated monitoring site under the specified flow conditions. Water quality and streamflow data used in evaluating impairment conditions, loading sources and TMDL calculation for the Blackfoot River are included in Appendix C.

5.4.3 Blackfoot River Source Load Allocations

Different approaches are used for allocating metals loads in the Blackfoot River upstream and downstream of Pass Creek. For the stream segment above Pass Creek (and entirely within the UBMC Implementation Plan boundaries), a performance-based approach to load allocation and waste load allocation as applied to Beartrap Creek is used. The performance based approach is based on the assumption that water quality restoration requirements mandated in the UBMC Temporary Standards Implementation Plan (Appendix B) will address all human-caused sources of metals-related water quality impairment in this portion of the Blackfoot River. For the segment of river between Pass Creek and Landers Fork, a source-specific approach to load allocation is used. Load allocations for the two stream segments are discussed below.

5.4.3.1 Waste Load and Load Allocations Upstream of Pass Creek

Due to the presence of one point source discharge (discharge from the wetlands-based water treatment system, MPDES #MTR0030031), source load allocations in the Blackfoot River upstream of the confluence with Pass Creek include both a waste load allocation (point source) and load allocations (nonpoint sources). A performance based allocation approach is taken for the waste load and load allocations. This performance-based approach recognizes the ongoing mine reclamation activities in the drainage, and the regulatory programs and cleanup commitments currently in place as part of the Temporary Water Quality Standards process. As stipulated in the Montana water quality regulations (MCA 75-5-312), before the Board of Environmental Review can grant temporary standards to a water body, the petitioner must submit an implementation plan designed to eliminate the water quality limiting factors to the extent considered achievable, and a schedule for implementing the plan that ensures that the water quality standards are met as soon as reasonably practicable, and in no event later than the time allowed by the Board in the temporary standards. At this time it is assumed that all significant human-caused sources of metals loading to the Blackfoot River upstream of Pass Creek are or will be identified and addressed by the Temporary Standards Implementation Plan reclamation program. In the event that post-reclamation water quality monitoring as required by the Implementation Plan shows that B-1 classification standards (and thus the water quality restoration targets) are not being met, the causes and sources for continued water quality impairments must be identified and mitigated (except natural background sources) to the extent considered achievable. Therefore, the Temporary Standards regulations include built-in contingencies to ensure that all human-caused sources of water quality impairment to the Blackfoot River upstream of Pass Creek are ultimately identified and addressed.

The Temporary Standards Implementation Plan (Appendix B), includes a description of all known or suspected sources of metals loading to affected surface waters within the UBMC Implementation Plan boundary, including the Blackfoot River. Sources associated with performance based load and waste load allocations and identified in the plan include:

- Surface water inflow from Beartrap Creek drainage (load allocation);
- Discharge from the constructed wetlands-based mine water treatment system (waste load allocation);
- Surface water inflow from Stevens Gulch (load allocation);
- An area of Concentrated tailings on the Blackfoot River floodplain near the confluence with Shave Creek (load allocation);
- Dispersed Tailings located along the Blackfoot River floodplain (load allocation); and
- Surface water inflow from Paymaster Creek (load allocation).

The Implementation Plan includes a reclamation schedule and options for addressing each of these sources. Annual sampling and analyses plans and work plans are to be prepared annually for review by MDEQ to guide site characterization and reclamation planning. Annual reports summarizing the previous years activities are also required under the Implementation Plan for MDEQ review (Appendix B).

Each of the sources listed above is shown in Figure 5-2 and described in detail in various reports (Hydrometrics, 1999, 2000, 2001a, 2002). Following is a brief discussion of each source, and restoration options and schedules included in the Temporary Standards Implementation Plan.

Surface Water Inflow from Beartrap Creek Drainage: Metals loading sources and trends in Beartrap Creek drainage are described in Section 4. Known sources include surface water inflow from Mike Horse Creek, seepage from the Mike Horse tailings impoundment, dispersed floodplain tailings, and possible seepage and runoff from the Flosse and Louise Mine (Figure 4-1). All known sources of metals loading in Beartrap Creek drainage are addressed in the Temporary Standards Implementation Plan with reclamation activities scheduled by 2006 (Hydrometrics, 2000). This schedule may be extended by up to two years based on completion of negotiations between the Forest Service and Asarco.

Discharge from Wetlands-Based Water Treatment System: In 1996, Asarco constructed, and currently operates, a wetlands-based water treatment system for treatment of mine drainage from the Mike Horse 300 level adit and Anaconda Mine adit. Discharge from the treatment system is regulated under the Montana Pollutant Discharge Elimination System (MPDES) permitting program (MPDES Permit No. MTR0030031). The discharge permit stipulates effluent limits for the metals cadmium, copper, iron, lead, mercury and zinc. The implementation plan requires Asarco continue to optimize the water treatment system to decrease metals concentrations in the effluent by enhancing the treatment system efficiency, and/or decreasing metals concentrations in the influent through pretreatment steps or source control. Under the performance based approach, this discharge will ultimately be set at levels that satisfy the targets and water quality standards in a manner consistent with MPDES permitting requirements. Therefore, for each metal the waste load allocation is set equal to the load that results in discharges that either satisfy numeric water quality standards within the discharge water or within the receiving stream where a mixing zone approach is used. MPDES permitting currently requires no exceedence of any acute aquatic life standards within the mixing zone and no exceedence of any chronic aquatic life standards at the end of the mixing zone. The use of a mixing zone for human health standards is a case-specific permit determination. The TMDL equation presented in Appendix A, along with

applicable mixing zone equations, would apply under all stream flow and discharge conditions. This will require additional significant reductions in discharge loads from this source area given the high percentage of metals loading from this source, particularly during low flow conditions (reference Section 5.3.2.1).

Surface Water Inflow from Stevens Gulch Drainage: Stevens Gulch enters the Blackfoot River from the south approximately 2,500 feet upstream of monitoring site BRSW-12 (Figure 5-2). As described in Section 5.3, metals loading from the drainage to the Blackfoot River has been documented through extensive water monitoring (Hydrometrics, 2002). Stevens Gulch drainage has been the site of historic mining activities, with one mine (the Capital Mine) reclaimed by Asarco in 1997. The implementation plan schedule includes mitigation of additional human-caused sources of metals loading in Stevens Gulch drainage between 2003 and 2006.

Concentrated Floodplain Tailings Deposits: An area of concentrated tailings has been identified on the Blackfoot River floodplain near the confluence with Shave Creek (Figure 5-2). 2001 implementation plan activities include delineation of the lateral and vertical extent of tailings, and determination of the tailings physical and chemical characteristics (Hydrometrics, 2002). Reclamation options specified in the plan include: complete or partial removal of tailings and placement in an engineered repository; consolidation of tailings with local closure; and in-place closure through soil amendment and revegetation. Reclamation of the dispersed tailings is scheduled to occur between 2003 and 2005 with possible extension of the schedule by up to two years based on completion of ongoing negotiations between the U.S. Forest Service and Asarco.

Dispersed Floodplain Tailings: Dispersed tailings occur along the Blackfoot River floodplain from the confluence of Beartrap and Anaconda Creeks, downstream to the head of the marsh system near the confluence with Pass Creek (Figure 5-2). 2001 implementation plan activities include mapping and characterization of the dispersed tails (Hydrometrics, 2002). Reclamation options listed in the implementation plan include: complete or partial removal of tailings and placement in an engineered repository; consolidation of tailings with local closure; and in-place closure through soil amendment and revegetation. Reclamation of the dispersed tailings is scheduled to occur between 2003 and 2005 with possible extension of the schedule by up to two years based on property access issues and ongoing negotiations between the U.S. Forest Service and Asarco.

Surface Water Inflow from Paymaster Creek Drainage: Paymaster Creek enters the upper marsh system on the Blackfoot River between monitoring site BRSW-12 and the confluence with Pass Creek (Figure 5-2). The lower 2000 feet of Paymaster Creek has been impacted by the historic Paymaster Mine, which was reclaimed by Asarco in 1996-97. Asarco constructed a second wetlands-based water treatment system at the Paymaster Mine for treatment of a seasonal discharge from the Paymaster Adit. The Paymaster treatment system discharges to groundwater and is regulated under the Montana Groundwater Pollution Control System (MGWPCS) program (Permit No. MGWPCS-001001).

Despite the mine reclamation and water treatment efforts, Paymaster Creek remains a source of metals loading to the Blackfoot River (Section 5.3). Previous investigations in the drainage

indicate that natural background sources may account for at least a portion of the remaining metals load (Furniss, 1998). Although additional water quality restoration activities for Paymaster Creek drainage are not specifically addressed in the Temporary Standards Implementation Plan, the overall plan requirements of attaining B-1 classification water quality standards in the Blackfoot River, to the extent considered achievable, will require any additional human-caused sources of metals-related water quality impairment in the drainage to be addressed.

All sources of metals loading to the Blackfoot River upstream of Pass Creek as listed above (with the exception of Paymaster Creek drainage) are specifically addressed and scheduled for reclamation in the Temporary Standards Implementation Plan. The overall goal of the temporary standards, meeting B-1 classification water quality standards to the affected portion of the Blackfoot River, will ensure that any remaining human-caused sources of impairment in Paymaster Creek drainage are also addressed. Completion of implementation plan activities is expected to result in attainment of the water quality restoration targets listed in Table 5-6 and the required metals TMDLs unless precluded by naturally occurring sources. It is assumed that all UBMC restoration activities will be implemented in a manner consistent with all reasonable land, soil and water conservation practices thereby satisfying the intent of Montana's Water Quality Standards for metals, including appropriate monitoring and maintenance to ensure reclamation success (ARM 17.30.602(21)).

It should be noted that additional historic mining disturbances do exist within the Blackfoot River drainage upstream of Pass Creek. Examples include the Viking Mine at the head of Stevens Gulch, the Mary P mine waste pile located in the Blackfoot River drainage bottom upstream of Stevens Gulch, and a number of small mines located in Shave Gulch drainage. These mines are located primarily on National Forest System Lands and are not addressed in the implementation plan. Existing information indicates that these mine disturbances do not represent significant sources of water quality impairment to the Blackfoot River. As with Paymaster Creek, if detailed water quality monitoring required by the implementation plan shows that B-1 standards are not being met following completion of reclamation activities, additional site investigation and reclamation activities will be required to address remaining human-caused sources of metals loading which may individually, or collectively, cause metals-related water quality standards to be exceeded. In the event that additional sources of water quality impairment are identified and required restoration activities do not fall under the Implementation Plan requirements, load allocation(s) will be identified for these additional sources as needed. Any necessary load allocation will be consistent with the load or load reduction needed to satisfy the water quality targets and B-1 standards in the Blackfoot River and any potentially impacted tributary.

If the performance based allocation approach discussed above should undergo significant delays or otherwise run into significant implementation problems, then a specific source category allocation approach will apply. Under this scenario, the load allocations for mining related sources as well as natural background sources will be set equal to the TMDL as defined by the TMDL equation. The waste load allocation associated with the mine discharge will be developed in such a way that the discharge does not exceed any metals numeric standards associated with a B-1 classified water body.

5.4.3.2 Load Allocation for Blackfoot River Downstream of Pass Creek

The load allocation approach presented above addresses metals loading sources that originate upstream of Pass Creek and are a major source of metals loading to the Blackfoot River downstream of Pass Creek. There currently are not any ongoing reclamation activities or mandated reclamation efforts in place to address other metals-related sources of loading downstream of Pass Creek. Therefore, a source-area approach to load allocation is used for this segment of river instead of the performance-based approach used upstream. The source area load allocation approach is well suited for this river segment where areas of increasing metal loads have been identified (Section 5.3), but sufficient information is not currently available to identify and quantify individual loading sources. The source area load allocations developed below can be used to guide future source area characterization efforts and restoration planning.

Metals loading source areas to the Blackfoot River between Pass Creek and Landers Fork were discussed in Section 5.3 and include:

- The Upper Blackfoot Mining Complex area above BRSW-12;
- The Upper Marsh system located immediately downstream of the UBMC Implementation Plan boundary (between monitoring sites BRSW-12 and BRSW-31); and
- All Remaining Potential Sources, which may include: metals loading from surface water inflow from tributary drainages; historic mining impacts along the Blackfoot River downstream of the UBMC Implementation Plan boundary such as mine waste deposited along the drainage bottom; or recharge of mining-impacted and/or naturally mineralized groundwater to the river.

In order to ensure protection of beneficial uses in the entire segment of river between Pass Creek and Landers Fork, the source area load allocations are based on the TMDLs, or metals loading capacity, as calculated at two separate locations: monitoring sites BRSW-31 and SP-SW-1.B (Figure 5-1). The sum of the load allocations for upstream source areas must be equal to or less than the TMDL for each metal of concern at each location. Following is a discussion of load allocations by source area.

Upper Blackfoot Mining Complex

Metal loads in the Blackfoot River exiting the UBMC area above monitoring site BRSW-12 represent a source of metals loading (and impairment) to the downstream river segment. Load and waste load allocations for this source area are already addressed through the metals TMDLs and allocations applied to the Blackfoot River within the UBMC upstream of BRSW-12 (Section 5.4.3.1).

Upper Marsh Area

Existing water quality data show concentrations (and loads) of several metals increase through the marsh complex immediately downstream of the Blackfoot River/Pass Creek confluence (Figure 5-2). The metals loading analysis (Section 5.3.2) shows that iron loads increase through the Upper Marsh during both high and low flow conditions, copper and manganese loads increase under low flow and decrease under high flow, and zinc, lead and cadmium loads

typically decrease or remain unchanged through the marsh. Water quality data also show that these metals typically exceed numeric water quality criteria immediately downstream of the marsh at site BRSW-31. Although the precise cause for load increases through the marsh is not currently known, possible sources include: metals-bearing sediments deposited within the marsh; tributary inflows; and/or recharge of mine-impacted and/or naturally mineralized groundwater to the river.

In order to address water quality impairments associated with metals loading from the Upper Marsh area, a source area load allocation is applied to the Upper Marsh. The source area load allocation is based on maintaining metals concentrations in the Blackfoot River within and downstream of the marsh at levels below the applicable B-1 based numeric water quality restoration targets, as well satisfying the sediment toxicity and macroinvertebrate and periphyton restoration targets applied to the Blackfoot River (Section 5.4.1). Since the metals TMDLs developed for monitoring site BRSW-31 (located at the downstream end of the Upper Marsh) are based on meeting these targets under all streamflow and water hardness conditions, each metal load allocation for the Upper Marsh source area is set at levels that would satisfy the corresponding TMDL at BRSW-31 once restoration targets are satisfied at BRSW-12. Therefore, the metals loading from the Upper Marsh plus any remaining metals load that can be attributed to the UBMC area above BRSW-12 must be equal to or less than the TMDL for each applicable metal.

The load allocations for the Upper Marsh source area apply to all potential contributing sources including: tributary inflows, potential metals-bearing sediments within the marsh, and recharge from mineralized groundwater. Tributaries entering the upper marsh include Pass Creek, Swamp Gulch, Meadow Creek and Paymaster Creek (Paymaster Creek is part of the UBMC reclamation program however and is addressed within the UBMC performance-based load allocations in Section 5.4.3.1). A more detailed accounting of potential contributing sources is necessary before the Upper Marsh source area load allocation can be further refined, and restoration requirements and options determined. For some metals, satisfying the allocation for the UBMC above BRSW-12 during high and/or low flow may result in a situation where the TMDL for that metal is also satisfied at BRSW-31.

Remaining Sources

The metals loading analysis included in Section 5.3.2 shows that the primary sources of metals loading with the Blackfoot River are located within or upstream of the Upper Marsh. The loading analysis also shows however, that loads of certain metals, particularly iron and copper, increase in the stream segment between the upper marsh and Landers Fork (Figure 5-4). Appendix C data also indicates aluminum loading increases in this segment during high flow, although aluminum has not been identified as one of the metals causing impairment to this segment of the Blackfoot River at this time since elevated levels may be associated with naturally occurring conditions. Because sufficient information is not currently available to quantify individual loading sources in this downstream reach, potential loading sources are grouped under the Remaining Sources category. Potential remaining metals loading sources include, but may not be limited to: metals loading from surface water contributions from tributary drainages; possible historic mining-related impacts along the Blackfoot River drainage bottom (i.e., metals-bearing sediments); or recharge of mining-impacted and/or naturally mineralized groundwater to the river.

At this time, load allocations may not be necessary for the Remaining Sources category since existing water quality data indicate that mitigation of all metals loading sources within and upstream of the Upper Marsh will result in attainment of all metals-related water quality restoration targets downstream of the Upper Marsh as well. In other words, documented load increases downstream of the Upper Marsh do not by themselves appear to cause impairment conditions. Nevertheless, load allocations are applied to the mouth of each major tributary drainages downstream of the Upper Marsh. These allocations are set at levels that would satisfy all B-1 water quality standards, within each tributary, and need only apply to those tributaries where impairment conditions are subsequently documented via formal MDEQ procedures (MDEQ, 2002). Although these allocations, if needed, may not result in noticeable improvements to the Blackfoot River for most metals, they can contribute to a margin of safety in addition to improving beneficial use support conditions within the tributary of concern. Including these load allocations within this document can help focus future assessment and restoration planning in tributaries where important fisheries may exist.

Another Remaining Source category where load allocations are developed is the lower marsh areas shown on Figure 5-1. The apparent metals sink and source characteristics of these marshes will need to be further investigated to see if localized impairment conditions associated with water column, sediment, or floodplain chemistry could persist within the lower marshes even after all restoration targets are met at upstream sources. Given the copper and iron load increases documented through the lower marshes (Figure 5-4), and the potential for metals-bearing sediments to accumulate in the marshes from historic mining activities, these locations may represent localized source areas in need of load allocations. Therefore, an additional performance based allocation is applied at this time to both of these lower marsh areas to address the potential need for water quality restoration activities. Restoration activities would be pursued as necessary to ensure that all TMDL restoration targets for the Blackfoot River are met and the B-1 based beneficial uses can be achieved. This could lead to additional target compliance locations as needed to support beneficial uses within this section of the Blackfoot River. Section 6.3 outlines a water and sediment monitoring program designed to further characterize possible Remaining Source Category sources, including the lower marsh area sediments and tributary drainages.

5.5 Blackfoot River from Landers Fork to Nevada Creek

The segment of the Blackfoot River from Landers Fork to Nevada Creek (MT76F001-020) was listed as partially supporting of aquatic life and cold water fishery on the 1996 303(d) list with metals being one of the identified causes (Table 1-1). Recent 303(d) lists (2000, 2002) have not shown this segment as being impaired for metals, due in part to MDEQ reviews of 1995 through 1997 water quality data from monitoring sites along the Blackfoot River (Lawlor, 2000), and also due to results of sampling by MDEQ in 2001. The 1995-97 sites include one site in the lower part of this segment above Nevada Creek near Helmville (USGS Station Number 12335100), one in the middle part of this segment near the Dalton Mountain Road bridge (USGS Station Number 12334800), and one in the upper part of this segment below Seven-up-Pete Creek (USGS Station Number 12334700). Appendix C presents data for all three sites, including

data for 1993 through 1995 at the upstream site, data for 1995 through 1997 at all three sites as discussed above, and data for 2002 at all three sites.

The data from all three sites occasionally exceed the 300 ug/l drinking water use guidance value for iron during high flow, and the data from the upper and lower sites occasionally exceed the 50 ug/l drinking water use guidance values for manganese during high flow. Based on the level and frequency of exceedences, and the likelihood that elevated levels of iron would be removed during conventional treatment, the data suggests that the drinking water beneficial use is not impaired (reference Appendix A).

Water quality data from the upper site (Blackfoot River below Seven Up-Pete Creek) include two exceedences of the chronic aquatic criteria for cadmium and iron, and one exceedence for aluminum and zinc. All of these exceedences occurred between 1993 and 1995, with no exceedences of the chronic criteria recorded since 1995. Water quality data from the lower site (above confluence with Nevada Creek), show one exceedence of the chronic aquatic standard for cadmium (10% above the standard) and iron (20% above the standard) each, during June 2002. In addition to the above water quality data, MDEQ collected river sediment samples for total metals analyses, and macroinvertebrate and periphyton data from the lower part of this segment in 2001. The sediment sample results indicate no metals at levels of concern, the macroinvertebrate data indicates no metals related problems, and the periphyton result for percent abnormal diatom cells indicates some potential metals related impact, but generally not enough to conclude that there is an impairment condition based on this data alone.

The water quality exceedences summarized above for the Blackfoot River between Landers Fork and Nevada Creek, although somewhat infrequent and limited to high flow conditions, indicate a borderline aquatic life and cold water fish impairment situation per MDEQ Water Quality Assessment Process and Methods (MDEQ, 2002).

Much of the metals loading, particularly in the upper-most portion of this segment is apparently due to metals loads from the Blackfoot River drainage above Landers Fork, with some potential loading from Landers Fork and Seven Up Pete Creek. Further downstream, loading trends indicate there are additional sources of iron and possibly cadmium loading. Potential downstream sources include inflows from tributaries such as Poorman Creek, and possibly leaching or re-suspension of metals from river or floodplain sediments. The data throughout the watershed also indicate the possibility of relatively high natural background loads, although increased erosion from human activities could also be contributing to loading from mineralized areas.

It is anticipated that meeting the targets and satisfying all load allocations in the Blackfoot River drainage upstream of Landers Fork, as discussed within Sections 5.1 through 5.4, may result in fully supporting conditions in the Blackfoot River immediately downstream of Landers Fork, and possibly the entire stream segment downstream to Nevada Creek. As an added level of assurance, the high flow water column metals targets for cadmium, iron and zinc that apply to Blackfoot River Site SP-SW-1.B above the Landers Fork (Table 5-6), along with the appropriate TMDLs as defined by the TMDL equation in Appendix A, are applied to the Blackfoot River below Seven Up-Pete Creek (USGS Station Number 12334700) and the Blackfoot River above

Nevada Creek (USGS Station Number 12335100). Aluminum is also added as a high flow target, with the target value based on the B-1 chronic aquatic life support criteria of 87 ug/l. In addition, the load allocations applied to the tributary drainages between Pass Creek and Landers Fork (reference “Remaining Sources” under Section 5.4.3.2), also apply to the Landers Fork and Seven Up Pete Creek, and any other tributaries where it is subsequently concluded that impairment conditions exist for iron, cadmium, zinc, aluminum, and/or any other metals of concern. This means that the allocations for these tributary water bodies are set at levels that would satisfy all B-1 water quality standards within each tributary, and would only apply where impairment conditions are subsequently documented via formal MDEQ procedures (MDEQ, 2002).

An adaptive management TMDL development and implementation approach is applied for the segment of the Blackfoot River between the Landers Fork and Nevada Creek. The goal of this approach is to pursue the activities listed below as necessary to meet the applicable metals targets:

1. Continue with UBMC restoration efforts upstream where load reductions are anticipated.
2. Continue with restoration planning and TMDL implementation in Sandbar Creek and the Poorman Creek drainage.
3. Continue with development and implementation of the water quality and habitat restoration plan (currently in draft), which includes sediment TMDLs that could result in reduced metals transport via erosion.
4. Obtain more data where necessary and make beneficial use determinations in other tributary drainages downstream of Pass Creek where existing data indicates potential metals-related impairment conditions may exist. Develop TMDLs and associated targets and allocations for the tributaries where impairment conditions are identified.
5. Determine the potential for additional loading from the two lower marshes of the Blackfoot River upstream of Landers Fork.
6. Continue monitoring within the Blackfoot River as needed to update beneficial use support determinations, better delineate the extent and sources of metals-related impairment, and evaluate progress toward meeting targets. This information will help evaluate and document anticipated improvements from UBMC and other restoration efforts defined within the Water Quality Restoration Plan for Metals in the Blackfoot Headwaters TMDL Planning Area.
7. If the above activities do not eventually result in metals concentrations consistent with full use support conditions, then pursue additional studies to identify remaining metals loading sources and apply additional load allocations where appropriate.

Following the above adaptive management approach will lead to a better understanding of and resolution to water quality impacts and beneficial use limitations within this segment of the Blackfoot River from Landers Fork to Nevada Creek.

SECTION 6.0

RESTORATION STRATEGY

This section outlines strategies for addressing metals loading sources in need of restoration activities within the Blackfoot Headwaters TMDL Planning Area (planning area). The restoration strategies focus on regulatory mechanisms and/or programs applicable to the particular source types present within the planning area, which for the most part are associated with historic mining. The strategies identified below address currently known or suspected sources, as well as additional sources of metals-related impairment which may be identified through future investigations. The planning area is divided into two geographical areas for discussion of restoration strategies; the portion of the planning area located within the Upper Blackfoot Mining Complex Implementation Plan boundaries (Beartrap Creek/Mike Horse Creek and the Blackfoot River Upstream of Pass Creek); and that located outside of these boundaries (Sandbar Creek, Willow Creek, Poorman Creek, and the downstream Blackfoot River segments).

Also presented in this section is a monitoring program designed to more fully quantify impairment conditions and individual metals loading sources in portions of the listed stream segments. The monitoring program is also intended to assess the effectiveness of current (UBMC) and future restoration activities designed to meet the restoration targets and TMDLs presented in this plan. The monitoring plan also includes provisions for assessing stream segments not listed as impaired for metals, but available data show have exceeded B-1 classification numeric criteria for certain metals on an occasional basis.

6.1 Restoration Strategy for Sources Covered Under the UBMC Implementation Plan

Restoration strategies for the listed portion of Beartrap Creek and the Blackfoot River upstream of Pass Creek, as well as the metals-impaired segment of Mike Horse Creek, are primarily addressed by the Upper Blackfoot Mining Complex Temporary Standards Implementation Plan (Appendix B). As stated in the Temporary Standards regulations, when the board adopts temporary standards, the goal is to improve water quality to the point where all beneficial uses designated for the water body or segment are supported (75-5-312(1)). Since the restoration targets established for Beartrap Creek, Mike Horse Creek, and the Blackfoot River upstream of Pass Creek are based on attainment of all B-1-based beneficial uses, the goals and requirements of the temporary standards mine reclamation program are consistent with the goals and requirements of this water quality restoration plan.

In accordance with Section 75-5-312(4), the Temporary Standards Implementation Plan submitted to the Board of Environmental Review by Asarco includes a description of known sources of metals-related water quality impairments, general remedial options for eliminating these sources to the extent considered achievable, and an implementation schedule. The Implementation Plan source inventory is based on detailed site characterization activities conducted by Asarco from 1991 through 1999 and is believed to represent the vast majority of metals-related water quality impairment sources at the UBMC.

The Implementation Plan schedule requires all identified sources of water quality impairment to be addressed by 2006, with a possible extension of up to two years pending completion of negotiations between Asarco and the U.S. Forest Service. The Implementation Plan schedule also requires Asarco conduct seasonal water quality monitoring in association with reclamation activities to assess compliance with the temporary standards, and post reclamation monitoring for two years following completion of scheduled reclamation activities (Section 6.3).

Monitoring results will be used by MDEQ and the Board of Environmental Review to determine if the scheduled reclamation activities are successful in restoring surface waters at the UBMC to B-1 classification water quality standards to the extent considered achievable. If B-1 standards are not being met, remaining sources must be identified and addressed as appropriate (except for natural background sources if shown to exist). Therefore, the goals and requirements of the Temporary Standards program as applied to the UBMC are expected to result in attainment of the metals restoration targets and TMDLs in Mike Horse Creek, Beartrap Creek and the Blackfoot River upstream of Pass Creek. Although the Temporary Standards water quality restoration requirements do not extend to sources downstream of Pass Creek, these activities are expected to result in significant water quality improvements in the Blackfoot River downstream of the UBMC Implementation Plan boundaries as well.

In addition to the Temporary Standards requirements, Asarco and the U.S. Forest Service entered into an administrative order on consent (AOC) in February 2003 for an Engineering Evaluation/Cost Analysis (EE/CA). The purpose of the EE/CA is to address certain historic mining impacts at the UBMC. The EE/CA will be prepared in accordance with EPA's Guidance on Conducting Non-Time Critical Removal Actions Under Comprehensive Environmental Response, Cleanup and Liability Act (CERCLA) (EPA, 1993). Non-Time Critical Removal Actions are defined by the CERCLA and the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) as actions that are implemented by the lead agency for "the cleanup or removal of released hazardous substances from the environment...as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare, or to the environment..." As such, the EE/CA will in part compliment the Implementation Plan requirements and will further ensure that sources of metals-related water quality impairment at the UBMC are adequately characterized and addressed through these established reclamation programs.

6.2 Restoration Strategy for Sources Outside of the UBMC Implementation Plan Boundary

Stream segments listed as impaired for metals and/or in need of additional data and located outside of the UBMC Implementation Plan boundaries include: Sandbar Creek, Willow Creek, Poorman Creek, the Blackfoot River between Pass Creek and Landers Fork, and the Blackfoot River between Landers Fork and Nevada Creek. Currently, there are no ongoing restoration programs or scheduled restoration activities aimed at mitigating mining related metals loading sources in these drainages, other than the UBMC efforts that will ultimately mitigate impairment conditions in the downstream sections of the Blackfoot River. In some cases, specific metals loading sources or source areas have been identified in these drainages, such as two mine waste dumps in Sandbar Creek drainage (Section 2), Swansea Gulch in Poorman Creek drainage (Section 3), and the upper marsh on the Blackfoot River (Section 5). In other cases, available water quality data indicate that additional metals loading sources exist in these drainages,

although specific loading sources cannot be identified and adequately delineated based on available information. Available water quality data also suggests that certain tributary drainages not listed as being impaired for metals may exceed B-1 classification water quality standards for some metals on an occasional basis. Examples include Alice Creek, Hogum Creek, Hardscrabble Creek, and Seven-Up Pete Creek (Appendix C).

Following is a discussion of general restoration programs and funding mechanisms applicable to both listed and unlisted water bodies within the planning area and outside of the UBMC Implementation Plan boundary. The need for further characterization of impairment conditions and loading sources in some stream segments is addressed in Section 6.3 under the water quality monitoring program.

6.2.1 General Restoration Options

A number of state and federal regulatory programs have been developed over the years to address water quality problems stemming from nonpoint sources of pollution. Nonpoint sources of pollution, particularly historic mines and associated disturbances, constitute the majority of the metals loading sources to the Blackfoot Headwaters TMDL Planning Area. Some regulatory programs and approaches considered most applicable in the planning area include:

- The State of Montana Mine Waste Cleanup Bureau's Abandoned Mine Lands (AML) Reclamation Program;
- The Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA) which incorporates additional cleanup options under the Controlled Allocation of Liability Act (CALA) and the Voluntary Cleanup and Redevelopment Act (VCRA); and
- The federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Montana Mine Waste Cleanup Bureau Abandoned Mine Reclamation Program

The Montana Department of Environmental Quality's Mine Waste Cleanup Bureau (MWCB), part of the MDEQ Remediation Division, is responsible for reclamation of historical mining disturbances associated with abandoned mines in Montana. Historical mining-related disturbances are believed to comprise the majority of metals-loading sources in the planning area. Therefore, the MWCB abandoned mine reclamation program may be a viable alternative for addressing certain metals loading sources in the planning area.

The MWCB abandoned mine reclamation program is funded through the Surface Mining Control and Reclamation Act of 1977 (SMCRA) with SMCRA funds distributed to states by the federal government. In order to be eligible for SMCRA funding, a site must have been mined or affected by mining processes, and abandoned or inadequately reclaimed, prior to August 3, 1977 for private lands, August 28, 1974 for Forest Service administered lands, and prior to 1980 for lands administered by the U.S. Bureau of Reclamation. Furthermore, there must be no party (owner, operator, other) who may be responsible for reclamation requirements, and the site must not be located within an area designated for remedial action under the federal Superfund program or certain other programs. Abandoned Mine Lands Cleanup is discussed further in Appendix D.

Two sites within the planning area are currently on the MWCB's priority list of sites to be reclaimed with SMCRA funds (MDSL, 1995). These include the Swansea Mine and Tailings in Poorman Creek drainage, and the Seven-Up Pete/Rover Mine in Seven-Up Pete Creek drainage. The Swansea Mine and Tailings have been identified as a source of metals loading and water quality impairment to Swansea Gulch, a tributary to Poorman Creek. Although not listed for metals, available water quality data indicates that Seven-Up Pete Creek has exceeded numeric water quality criteria for certain metals on an occasional basis (Section 6.3). The Seven-Up Pete/Rover mine complex has been the subject of significant reclamation activities in the past but may still act as a source of metals loading to Seven-Up Pete (and possible Hogum) Creek.

Both the Swansea and Seven-Up Pete mines are ranked relatively low on the MWCB's list of priority sites (145 and 185 out of 273, respectively) meaning the reclamation schedules for these mines are uncertain at this time. However, inclusion on the priority list should result in eventual reclamation of these sites, assuming adequate funding through SMCRA, or some other source, is available.

In addition to the two sites included on the AML priority list, other known historic mining sources, such as the historic mining-related disturbances in Sandbar Creek drainage, may eventually be eligible for SMCRA funding for reclamation assuming they meet the eligibility criteria.

Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA)

Reclamation of historic mining-related disturbances administered by the State of Montana and not addressed under SMCRA typically are addressed through the MDEQ State Superfund or CECRA program. The CECRA program maintains a list of facilities potentially requiring response actions based on the confirmed release or substantial threat of a release of a hazardous or deleterious substance that may pose an imminent and substantial threat to public health, safety or welfare or the environment (ARM 17.55.108). Listed facilities are prioritized as maximum, high, medium or low priority or in operation and maintenance status based on the potential threat posed. The UBMC is a high priority CECRA listed facility, but cleanup is currently pursued via a voluntary cleanup approach based on an agreement between the responsible party and the State of Montana. The application of temporary water quality standards, as discussed throughout this document, provides an additional level of regulatory oversight from a water quality standards perspective. The only other CECRA-listed facility in the planning area is the medium priority Alice Creek Post and Pole Site. The Alice Creek site is not considered a potential source of metals loading to surface waters.

CECRA also encourages the implementation of voluntary cleanup activities under the Voluntary Cleanup and Redevelopment Act (VCRA), and the Controlled Allocation and Redevelopment Act (CALA). The CECRA program is discussed further in Appendix D.

It is possible that one or more historic mining-related metals loading sources in the planning area could be added to the CECRA list and addressed through CECRA, with or without the VCRA and/or CALA process. A site can be added to the CECRA list at MDEQ's initiative, or in response to a written request, containing the required information, made by any person to the department.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

CERCLA is a Federal program that addresses cleanup of sites, including historic mining areas, where there has been a release, or there is the threat of release, of a hazardous substance. Sites are prioritized on the National Priority List (NPL) using a hazard ranking system with the primary focus on protection of human health. Under CERCLA, the potentially responsible party or parties must pay for all remediation efforts based upon the application of a strict, joint and several liability approach whereby any existing or historical land owner can be held liable for restoration costs. Where viable landowners are not available to fund cleanup, funding can be provided under Superfund authority. The CERCLA program is discussed further in Appendix D.

Asarco and the U.S. Forest Service entered into an administrative order on consent in February 2003 for performance of an Engineering Evaluation/Cost Analysis under CERCLA for reclamation of certain mining disturbances on National Forest System lands at the UBMC. It may be possible for other water quality restoration activities, which may be required on public lands to be addressed under the EE/CA process, with or without a PRP.

6.2.2 Funding Options

In addition to the funding mechanisms associated with the regulatory programs discussed above, other funding mechanisms may be available for water quality restoration activities. Possible funding sources may include the yearly RIT/RDG grant program or the EPA Section 319 Nonpoint Source yearly grant program. The RIT/RDG program can provide up to \$300,000 to address environmental related issues. This money can be applied to sites included on the MWCBC's AML priority list but of low enough priority where cleanup under AML is uncertain (such as the Swansea Mine). RIT/RDG program funds can also be used for conducting site assessment/characterization activities such as identifying specific sources of water quality impairment.

Section 319 grant funds are typically used to help identify, prioritize, and implement water quality protection projects with focus on TMDL development and implementation of nonpoint source projects. Individual contracts under the yearly grant typically range from \$20,000 to \$150,000, with a 25% or more match requirement. RIT/RDG and 319 projects typically need to be administered via a non-profit or local government such as a conservation district, a watershed planning group, or a county.

There may be other grant programs and funding sources that could be utilized to help protect water quality and address environmental concerns, especially where such concerns are associated with an important resource such as the Blackfoot River. State and Federal agencies are often able to provide some assessment-related support. Where sufficient funding can be obtained, then detailed assessment and cleanup such as might occur under VCRA, could be pursued.

6.3 Monitoring Strategy

As noted throughout this water quality restoration plan, the availability of seasonal water quality data is limited for most stream segments outside of the UBMC Implementation Plan boundaries. For much of the Blackfoot Headwaters Planning Area, additional information is required to better define seasonal impairment conditions, to delineate specific metals loading sources, to support allocation of loads, and for restoration planning. In addition, environmental monitoring will be required to assess the effectiveness of future restoration actions and attainment of restoration targets.

Following is a conceptual environmental monitoring program for the Blackfoot Headwaters Planning Area. Ongoing monitoring activities as required by the Temporary Standards Implementation Plan are discussed first. Specific data needs for drainages or stream segments outside of the UBMC and/or downstream of Pass Creek are discussed last. The focus of the below monitoring is to address water quality and beneficial use support per Montana's State Surface Water Quality Standards within the context of TMDL development and implementation. Specific monitoring requirements beyond those discussed below will typically be imposed as part of any regulatory cleanup effort such as efforts associated with the UBMC and/or efforts associated with any of the regulatory options discussed in Section 6.2.1. These monitoring requirements may be associated with the protection and cleanup of surface waters in addition to other media such as soils or ground water, and may impose significant additional sampling requirements to further determine the extent of and risk posed by contamination in addition to requiring evaluation of specific remediation actions.

6.3.1 Existing UBMC Water Monitoring Requirements

Section 3.4 of the UBMC Temporary Standards Implementation Plan (Hydrometrics, 2000) includes a water quality monitoring program for the UBMC upstream from and including BRSW-12. The monitoring program requirements include collection of surface water samples from pre-established monitoring sites BRSW- 12, BRSW-9 and BRSW-29 on the Blackfoot River upstream of Pass Creek, BRSW-23 and BRSW-38 on Beartrap Creek, and BRSW-22 and BRSW-35 on Mike Horse Creek. The Blackfoot River and Beartrap Creek monitoring sites correspond to the sites utilized for TMDL development in these two stream segments (Sections 4 and 5).

Water sample analytical parameters include pH, specific conductance, water temperature and flow (field measurements); total recoverable and dissolved aluminum, cadmium, copper, iron, lead, manganese and zinc; and calcium, magnesium, sodium, potassium and sulfate.

Water samples are to be collected from each site four times annually including: during early runoff conditions (typically in April); near peak spring runoff (typically in May); during the falling limb of the spring runoff hydrograph (typically in June); and under baseflow conditions (fall). This sampling schedule covers the three flow regimes (early spring runoff, high flow, low flow) evaluated for TMDL development in Mike Horse, Beartrap Creek and the Blackfoot River upstream of Pass Creek. Monitoring is to continue until the Temporary Standards expire in 2008 (or 2010 if extended for two additional years per 17.30.630(2)(c)). This includes two years of

post-implementation monitoring to assess the effectiveness of currently planned reclamation activities on water quality restoration.

The UBMC monitoring program also includes biological monitoring for the purpose of documenting current baseline biological conditions. The monitoring program requires annual macroinvertebrate sampling at Blackfoot River site BRSW-12 through 2003, with future monitoring needs to be evaluated at that time.

The specific sampling schedule, locations, and analytical parameters outlined above represent the minimum UBMC project sampling requirements for the first three-year period that temporary standards are in effect (through 2003). During the first two years of the temporary standards program, field sampling activities have significantly surpassed these minimum requirements. Additional sampling has focused on further source area delineation and restoration planning activities including: sampling of 10 to 20 supplemental surface water sites per sampling event in addition to the seven required monitoring sites; extensive soil and mine waste sampling; additional macroinvertebrate sampling; and groundwater sampling (Hydrometrics, 2001a, 2002). After 2003, monitoring requirements will be reviewed by MDEQ and revised as appropriate pending project developments and informational needs. Additional future monitoring requirements will need to include monitoring of the performance of specific restoration activities and structures such as the Upper Mike Horse Repository and possible future repository sites in order to satisfy the performance based allocation approach discussed in Sections 4.4.3 and 5.4.3.1. Also, additional monitoring will be necessary to verify beneficial use support in tributary drainages.

In addition to the Temporary Standards Implementation Plan monitoring requirements, Asarco is required to collect monthly water samples of the discharge from the wetlands-based water treatment system they operate at the UBMC. This sampling is required under the facility MPDES permit (permit #MT-0030031), and includes testing for aluminum, arsenic, cadmium, copper, iron, lead, manganese, zinc, mercury, sulfate, pH, total suspended solids, and flow. The monitoring results allow calculation of monthly metals loading rates from the treatment system to the Blackfoot River (see Section 5.3.2.1 for discussion on overall loading impacts from this source). The sampling results are submitted to MDEQ on a monthly basis.

The existing UBMC monitoring program should provide the vast majority of environmental information required for any continued TMDL development, restoration planning, and target compliance determinations in Beartrap and Mike Horse Creeks, and the Blackfoot River upstream of Pass Creek. Preparation of annual sampling and analysis plans and monitoring activities reports as required by the Implementation Plan will provide TMDL planners (and other stakeholders) the opportunity to review and track environmental monitoring activities and results. Because current monitoring requirements include only two years of post-implementation monitoring (through 2008 or possibly 2010), additional monitoring program(s) may be required to ensure monitoring continues beyond this time if necessary.

6.3.2 Monitoring Strategy for the Remainder of the Blackfoot Headwaters Planning Area

There are no metals related monitoring programs similar in scope to the UBMC program currently being implemented elsewhere in the planning area. Although numerous water quality studies have been completed in the planning area (e.g. Nagorski et al., 2000, Lawlor, 2000), and other studies are likely to take place in the future, additional TMDL-specific monitoring likely will be required to address outstanding restoration planning issues. MDEQ will be responsible in many situations for ensuring that these monitoring efforts are undertaken and that the data is made available to appropriate stakeholders. At a minimum, any monitoring plans and activities that address this part of the monitoring strategy should be reviewed by MDEQ to ensure consistency with the goals of this plan, MDEQ monitoring and assessment protocols, data requirements for beneficial use determinations, and data requirements associated with specific remediation programs.

The TMDL-specific monitoring needs include additional assessment monitoring and implementation monitoring. Assessment monitoring addresses additional data needs for more complete delineation of metals-impaired stream segments throughout the headwaters planning area, better delineation of specific sources of metals impairment, refinement of load allocations in some drainages, and restoration planning. The implementation monitoring is required to assess the effectiveness of future restoration activities, to assess whether compliance with water quality standards has been obtained by evaluating progress toward meeting restoration targets, and to assist with any adaptive management decisions as needed. Implementation monitoring to assess progress toward meeting restoration targets is required by the TMDL rules (75-5-703(7) & (9)), and is also an integral component of the implicit margin of safety incorporated in the metals TMDLs developed in this restoration plan. Some general assessment and implementation monitoring requirements and recommendations are identified below.

It is important to note that the below monitoring requirements and recommendations are based on TMDL related efforts to protect beneficial uses in a manner consistent with Montana's Surface Water Quality Standards. Other regulatory programs with water quality protection responsibilities may impose additional requirements to ensure full compliance with all appropriate local, State and Federal laws. For example, reclamation of a mining related source of metals under CECRA will likely require source-specific sampling requirements, which cannot be defined at this time, to determine the extent of and risk posed by contamination and to evaluate the success of specific remedial actions.

6.3.2.1 Monitoring Needed for Further Source Assessment and Restoration Planning

Poorman Creek Drainage:

- Water quality data and possibly sediment chemistry data is needed from tributary drainages such as the upper South Fork drainage, McClellan Gulch, and other tributary drainages where mining has occurred and no current water quality data is available. This information will be used to better quantify water quality impairment conditions and potential metals loading sources in Poorman Creek drainage, and will likely lead to

detailed source specific characterization monitoring as discussed below for Swansea Gulch. Seasonal flows and likely pollutant transport mechanisms will need to be considered for developing a more effective characterization of source areas.

- Detailed water quality data and possibly sediment chemistry is needed from Swansea Gulch drainage to better delineate specific sources (and mechanisms) of metals loading from mining-related disturbances to Swansea Gulch (and thus Poorman Creek). Water quality sampling should quantify metal load contributions from various portions of the mine, and metals transport mechanisms (i.e., leaching of dissolved metals from mine waste via shallow groundwater or precipitation infiltration, or transport of particulate metals to surface waters through mine waste erosion). The detailed sampling should also assess possible sources upgradient of the Swansea Mine as indicated by the 1993 data (Section 3.3).

Sandbar Creek Drainage:

- Detailed water sampling is needed to further quantify the metals loading contribution from the three apparent identified sources. Sandbar Creek should be sampled immediately upstream and downstream of the two identified mine waste piles and the area of apparent mine waste road fill (Section 2.3). The resulting data will help quantify the metal loads attributable to each of these sources, which will help in restoration planning and prioritization. Sediment chemistry data will likely be needed from these sites as well.

Willow Creek Drainage:

- Additional water quality and biota sampling is needed upstream of Sandbar Creek (at a minimum) to make impairment determinations and to help identify metals loading sources if an impairment condition is identified.

Blackfoot River From Pass Creek to Landers Fork:

- Detailed water and sediment sampling is needed in the vicinity of the Upper Marsh where seasonal increases in Blackfoot River metals loads have been documented. Sampling should occur at points within the marsh (as well as at upstream and downstream sites) and flows measured (where possible) to better delineate areas of load increases. Potential tributary sources should also be sampled, as well as additional sediment and floodplain sampling.
- Detailed water sampling is needed in the vicinity of the two lower marshes, where localized metals-related impairment conditions may exist. Sampling should occur at points within the marshes (as well as at upstream and downstream sites) and flows measured (where possible) to better delineate areas of load increases. Sediment and floodplain sampling should be conducted, as should potential tributary sources (see below).

Blackfoot River From Landers Fork to Nevada Creek:

- Additional sampling is recommended to better quantify and determine the extent of impairment conditions at the upper and lower portions of this segment of the Blackfoot River. Sampling of tributaries with potentially significant metals loading is also needed, as discussed below.

Tributary Drainages

- Major Blackfoot River tributaries with potential metals impairment conditions not yet defined include Alice Creek, Hardscrabble Creek, Hogum Creek, Seven Up-Pete Creek, and Arrastra Creek, as well as several smaller drainages (Figure 5-1). Water quality data show detectable concentrations of aluminum, cadmium, copper, iron and manganese in one or more of these tributaries on an occasional basis. Existing water quality data also show periodic exceedences of the B-1 classification water quality standards have occurred in all the tributaries identified above except Willow Creek (Appendix C). Additional water quality data in coordination with analyses of existing data will be needed for most of these and possibly other tributary drainages to:
 - 1) Determine if these tributaries currently meet B-1 water quality standards; and
 - 2) Quantify possible metals loading from these tributaries to the Blackfoot River if B-1 standards are not met.

Sampling will need to be consistent with standard MDEQ protocols used for making beneficial use determinations where metal impairment conditions may exist. If warranted, the assessment of impairment conditions will be modified based on the resulting water quality data. The sampling results will also be used to further evaluate metals loading to the Blackfoot River from tributaries, to set specific load allocations where needed, and for restoration planning and prioritization.

6.3.2.2 Implementation Monitoring

Implementation monitoring is required in all impaired drainages to assess the effectiveness of specific restoration activities and progress toward ultimate attainment of the restoration targets defined within this plan. In accordance with TMDL regulations (75-5-703(7) & (9)), MDEQ will develop and undertake an implementation monitoring program in the Blackfoot Headwaters Planning Area, with focus on evaluating progress toward meeting restoration targets. Efforts to assess the effectiveness of specific restoration activities focused on individual sources or source areas will tend to be an inherent part of the specific regulatory program/approach utilized (Section 6.2.1). At this time it would not be appropriate to identify all of these monitoring details, although it is expected that there would be some overlap with efforts to evaluate attainment of the restoration targets discussed below.

Implementation monitoring to assess overall progress toward meeting the restoration targets identified in Sections 2 through 5 of this plan will include a combination of water quality monitoring, sediment sampling for metals concentrations, and biological monitoring. Implementation monitoring will be done at least once every five years as defined by the TMDL regulations, with additional monitoring performed as needed to ensure timely evaluation of completed restoration activities in a particular drainage.

This monitoring program may need to incorporate portions of the UBMC if the UBMC water monitoring requirements per the temporary standards program or some other agreement expire before target compliance is verified or if the program does not address all monitoring needed to

verify target compliance. Table 6-1 is a summary of minimal target compliance monitoring parameters and locations identified within this document. All monitoring efforts are to be done using standard MDEQ sampling and analyses protocols. The UBMC monitoring program locations used as target compliance locations are also included for completeness.

Table 6-1 Monitoring Locations and Parameters to Evaluate Target Compliance.

Stream	Location(s)	Parameters ¹	Flow Sample Period
Sandbar Creek	SCSW-1 & SCSW-2	Copper, Iron, Manganese, Aluminum.	High & Low Flow
	SCSW-1 and/or SCSW-2	Sediment Chemistry, Macroinvertebrate, Periphyton, no visible metals deposits	Low Flow
Willow Creek (contingent upon impairment finding)	Upstream of Sandbar Creek	Metals (as needed).	High and/or Low Flow (as needed)
	Upstream of Sandbar Creek	Sediment Chemistry, Macroinvertebrate, Periphyton (as needed)	Low Flow (if needed)
Poorman Creek Drainage	PCSW-4, PCSW-5, PCSW-6, PCSW-7, PCSW-3 (or 4127PO01), and other locations as identified	Metals (specifically Copper, Cadmium and Lead), Sediment Chemistry, Macroinvertebrate, Periphyton	High & Low Flow for Metals, Low Flow for Biota Sampling and Sediment Chemistry
Mike Horse Creek	BRSW-22	Copper, Iron, Manganese, Aluminum, Cadmium, Lead, Zinc.	High, Low Flow & Early Spring Runoff
	BRSW-22	Sediment Chemistry, Macroinvertebrate, Periphyton, no visible metals deposits	Low Flow
Beartrap Creek	BRSW-23	Copper, Iron, Manganese, Cadmium, Lead, Zinc.	High, Low Flow & Early Spring Runoff
	BRSW-23	Sediment Chemistry, Macroinvertebrate, Periphyton, no visible metals deposits	Low Flow
Blackfoot River (from above Pass Creek to Landers Fork)	BRSW-12, BRSW-31 & SP-SW-1.B	Copper, Iron, Manganese, Cadmium, Lead, Zinc.	High & Low Flow; plus Early Spring Runoff for BRSW-12
	BRSW-12, BRSW-31 & SP-SW-1.B	Sediment Chemistry, Macroinvertebrate, Periphyton, no visible metals deposits	Low Flow
Blackfoot River between Landers Fork and Nevada Creek	USGS Gaging Sites 12334700 & 12335100	Aluminum, Cadmium, Iron and Zinc	High Flow

1 – All metals samples are to be total recoverable except aluminum, which will be dissolved.

6.4 Action Items

Based on the findings of this TMDL and water quality restoration plan, the following action items are identified. These action items represent a logical next step in the Blackfoot headwaters water quality restoration process and are intended to facilitate transition into the implementation phase of the TMDL. One or more of the Blackfoot River watershed stakeholders, such as the Blackfoot Challenge, in conjunction with appropriate State and/or Federal government agencies,

may pursue implementation of these action items. The action items are listed and briefly discussed below.

1. Pursue Restoration Activities at the UBMC:

The most critical element for metals-related water quality restoration in the Blackfoot Headwaters Planning Area is continuation of the mine reclamation program at the UBMC. Reclamation activities completed by Asarco and ARCO from 1993 through 1998 have resulted in significant water quality improvements, with further improvement anticipated through Asarco's currently scheduled reclamation activities. Efforts should focus on ensuring that currently scheduled reclamation activities are completed in accordance with all reasonable land, soil and water conservation practices, and in accordance with the Administrative Order on Consent recently signed by Asarco and the U.S. Forest Service.

2. Sandbar Creek Restoration Activities:

The Sandbar Creek water quality restoration plan identifies two mine waste piles and a segment of road likely contributing to metals-related water quality impairment in Sandbar Creek and possibly in Willow Creek also. It is possible that these apparent sources constitute the majority, if not all, of the metals loading sources in the drainage. Efforts should focus on reclamation of these apparent sources following more detailed site characterization as outlined in the Monitoring Strategy (Section 6.3). Detailed surface water sampling should be initiated in early 2003 (starting in March or April) to better quantify metals loading rates and mechanisms from the three source areas, and to identify other potential loading sources through Sandbar Creek drainage. Additional information in the form of stream sediment chemistry and mine waste physical and chemical characteristics should be obtained so that reclamation planning can be pursued in 2003. Implementation planning will need to be coordinated with the U.S. Forest Service since the apparent source areas are believed to be located on National Forest System lands.

3. Poorman Creek Restoration Activities:

Similar to Sandbar Creek, restoration planning should be initiated in Poorman Creek drainage in 2003. The detailed water and stream sediment sampling outlined in Section 6.3 for Swansea Gulch, as well as other portions of Poorman Creek drainage, should be initiated in March or April 2003. This will allow for reclamation planning in Swansea Gulch, and delineation of impairment conditions and potential loading sources throughout the drainage. The Swansea Gulch activities would occur primarily on private property and will require coordination with the property owners.

4. Water Quality Sampling and Other Related Monitoring:

Monitoring activities outlined in Section 6.3 for Poorman Creek drainage, Sandbar Creek drainage, Willow Creek drainage, the Blackfoot River between Pass Creek and Landers Fork, the Blackfoot River between Landers Fork and Nevada Creek, and key tributary drainages, should be initiated in 2003. The Poorman Creek and Sandbar Creek monitoring requirements are covered in items 2 and 3 above. For the Blackfoot River, additional surface water and sediment sampling will be required to identify metals loading sources and mechanisms within the Upper Marsh, and to characterize possible

metals loading sources in the lower marsh complex. Surface water sampling is needed from select tributaries flowing into the Upper Marsh in addition to key tributaries flowing into the Blackfoot River downstream of the Upper Marsh.

5. Seek Funding Mechanisms:

Immediate efforts should focus on possible funding mechanisms for implementation of these action items. Possible funding mechanisms are discussed in Section 6.2 and in Appendix D. Funding may be pursued by private stakeholders, such as the Blackfoot Challenge, and/or State and Federal government agencies.

6.5 Adaptive Management Approach to Restoration

The water quality restoration targets and associated metals TMDLs presented in this water quality restoration plan are based on the goal of ultimate compliance with the B-1 classification water quality standards. Therefore, it is imperative that all significant sources of metal loading be addressed via all reasonable land, soil, and water conservation practices so that the restoration targets (and thus the B-1 standards) are met to the extent considered achievable. It is recognized however, that in spite of all reasonable efforts, attainment of the restoration targets may not be possible due to the potential presence of non-controllable human-caused sources and natural background sources of metals loading. For this reason, an adaptive management approach, consistent with the performance-based allocation approach for several water bodies within the UBMCI Implementation Plan boundaries, is adopted for all metals targets including those for waters outside the UBMCI Implementation Plan boundaries. Under this adaptive management approach, all metals identified in this plan as requiring restoration targets and TMDLs will ultimately fall into one of the three categories identified below:

- 1) The restoration targets are achieved or likely will be achieved due to the successful performance of restoration activities.
- 2) The target is not achieved and will likely not be achieved even though all applicable investigation and restoration activities have been undertaken in a manner consistent with all reasonable land, soil and water conservation practices. Under this scenario, site-specific water quality standards and/or a reclassification of the water body may be necessary. This would then lead to a new target (and TMDL) for the pollutant of concern, and this new target would either reflect the existing conditions at the time or the anticipated future conditions associated with the restoration work that was performed.
- 3) The target is not achieved and will not likely be achieved due, at least in part, to a failure to implement restoration actions in a manner consistent with all reasonable land, soil and water conservation practices. Under this scenario the water body remains impaired in recognition of the need for further restoration efforts associated with the pollutant of concern. The target may or may not be modified based on additional characterization efforts, but conditions still exist whereby additional pollutant load reductions are needed to support beneficial uses and meet applicable water quality standards via some form of additional restoration work.

For metals ultimately falling under Categories 1 or 2, restoration efforts will have been completed in a manner consistent with the restoration targets, which should allow applicable beneficial uses to be supported to the extent considered achievable. Continuous feedback associated with the performance of restoration work and follow-up monitoring will provide the information necessary to make decisions about the appropriateness of any given target. For the UBMC, this feedback will include the MDEQ reports to the Board of Environmental Review as required under the temporary water quality standards process, as well as review of post-implementation monitoring data from throughout the Blackfoot Headwaters TMDL Planning Area.

The MDEQ Remediation Division and/or MDEQ Standards Program personnel will provide the lead within MDEQ in making determinations concerning the appropriateness of specific mine cleanup activities relative to temporary standards requirements and/or Montana's expectations for mining cleanup efforts for any impairment condition associated with mining impacts. This includes consideration of appropriate evaluation of cleanup options, actual cleanup planning and design, as well as the appropriate performance and maintenance of the cleanup activities such as proper performance of any repository sites. Where NPDES permitted point sources are involved, the MDEQ Permitting Program personnel will also be involved. MDEQ TMDL program personnel will need to be involved in the above matters to ensure consistency in water quality restoration goals as they apply to beneficial use support. Determinations on the appropriate performance of all aspects of cleanup efforts, or lack thereof, will then be used along with available in-stream data to update impairment determinations. The information will also help determine any further cleanup/load reduction needs for any applicable water body and will ultimately help determine the appropriate target category as discussed above.

The U.S. Forest Service will be involved with some of the above decisions, especially where they involve work performed on or potentially impacting National Forest Lands. Other stakeholders, including opportunities for public comment, will also be involved as required under applicable regulations.

SECTION 7.0

PUBLIC AND STAKEHOLDER INVOLVEMENT

There have been several opportunities for public and stakeholder involvement in the development of this water quality restoration plan. The 303(d) lists that MDEQ develops every two years undergo public review, including public meetings. The draft version of this Water Quality Restoration Plan for Metals in the Blackfoot Headwaters underwent a one-month public comment period that started December 23, 2002. This included a public review notice with directions regarding how to access the Plan on the MDEQ website to encourage public input. MDEQ has reviewed and addressed the comments (Appendix F), with assistance from key stakeholders.

The Blackfoot Challenge has facilitated public and stakeholder involvement in cooperation with the Big Blackfoot Chapter of Trout Unlimited. Prior to and during the public comment period, a draft and a summary of this report was circulated via email to the Blackfoot Challenge Board, the Blackfoot Habitat and Water Quality Restoration Committee, ASARCO Incorporated, and other interested parties.

Because a large part of this overall plan revolves around restoration planning efforts for the Upper Blackfoot Mining Complex (UBMC), the public has had the opportunity to review and comment on the temporary standards and associated implementation work plan. Public involvement in the UBMC is any ongoing process through MDEQ and the Montana Board of Environmental Review public participation process.

Restoration work pursued outside the context of the UBMC will typically involve numerous stakeholders, including the affected public. There is a high level of stakeholder interest in metals related issues because of impacts to such a key fishery as the Blackfoot River and due to impacts on important species such as bull trout and westslope cutthroat trout. Additional areas for public and stakeholder involvement and comment may include comment on eventual target categories as described in Section 6.5 of the Plan. Public comment on target categories will be facilitated via comments on UBMC restoration plans, agency decisions associated with temporary standards or water body classifications, and/or comment on restoration plans outside the context of UBMC project.

Any future significant revisions to this plan or identification of water quality impairment conditions on future 303(d) lists will also undergo public review.

SECTION 8.0

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